WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO 73

January 1970
75¢

Transceiver Companion
Extra Class Study Course
& Scads More



336 2 meter elements at W2NSD/1





Amateur Slow Scan Color TV Approaches Perfection Slo-o-o-o-wly

73 MAGAZINE

#112, January 1970

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Entire contents copyright 1969 by 73, Inc., Peterborough, New Hampshire 03458. *People generally fall into one of two groups: the Construction Workers or the Wrecking Crew. Which are you?*

...de W2NSD/1

Wayne Green

Last month we carried Ken Sessions on the masthead as the FM editor. This probably needs some explanation. Ken (K6MVH), as you may know, has been the editor of the FM Journal for the last year, working in conjunction with Mike (WA8UTB), the publisher. It is easy to go overboard on this sort of thing, as the publishers of many past amateur radio magazines will attest. At any rate Mike and Ken agreed to split up, with Mike continuing the magazine as long as he could alone. Ken wrote to me and offered to run an FM department for 73.

Having just returned from a splendid demonstration of the joys of FM and the excitement of the repeater systems while visiting with Tom Nelson W6QGN, I jumped at the offer.

Ken, in the meantime, had pulled up stakes and moved from California to a job editing Electronic Packaging and Production magazine in Chicago. I called him a few times about some FM articles we had in the works and my good impression of him gained at the Saroc convention back in January was reinforced. Would he be interested in coming with 73? I didn't have much money to offer, but I did have a job that is about as much fun as a job can be for a dedicated ham, and New Hampshire is a fabulous place to live. So I called Ken and though it meant a substantial cut in salary, he quickly agreed to make the move. Since he had been working at EPP for just a few months they were a bit put out by the sudden change.

A couple of weeks later, Ken, his wife and seven children (count 'em–7) and a van load of ham gear (and furniture) arrived. Fortunately I was able to locate a nice home for him less than a mile from the 73 headquarters.

Ken will be running the editorial end of 73, while I tend to increasing the circulation, getting around to a few conventions, talk to a few clubs, maybe get off on a short DXpedition or two, work on plans for 73 to eventually go public, get Radio Today into gear, help with the new junior op that is due about the time this goes to press, work on plans for several other new magazines, and perhaps run ski classes for the 73 staff on bright snowy mornings.

Exit the Youth Forum

The Youth Forum in the October issue didn't work out too well, everything considered. This was the brainstorm of Ralph Irace WA1GEK, a 17 year old with more than the average amount of drive.

Ralph turned up here last July and wanted to do something about getting more teenagers interested in amateur radio. He felt that both 73 and Radio Today could help with this and he wanted a job with us. Being extremely shorthanded, I agreed to give him a trial proofreading articles as an editorial assistant. After a few days it was obvious that this was a mistake. His moods were mercurial, running from virtual catatonia to great agitation. Frankly, he scared most of the girls here and my wife was truly frightened. I laughed at her preposterous worries. I suppose that I should have known, for I laughed at her when she tried to warn me about Don Miller.

At any rate, after a couple of weeks Ralph went away. Shortly thereafter I received a fantastic letter from him saying that he had made copies of many of the documents here and would use them against me unless I came to terms with him. Since there is absolutely nothing here to hide, none of us could figure what could be in his mind or why he thought copies of old bills and letters would be of value to us or our competitors. I ignored him.

In late October, while I was out in California at the Bay Area hamfest, someone broke into the 73 offices and stole my two rifles, plus who knows what else. Our list of missing items is a long one. I reported the theft and dismissed it from my mind.

Then Dave Mann (Leaky Lines) sent me a clipping from the Hartford Times saying that Ralph Irace was being held for murder. According to the clipping, Ralph and a friend were returning from Florida in early November. The police discovered the body of Wayne Rubenstahl shot three times with a .30 caliber rifle on highway I-91 in Lumberton, N. C. The police there put out a warrant for Ralph's arrest for murder and he was arrested in Richmond, Virginia. The police said they were at a loss for a motive for the murder.

I was dumbfounded.

As I thought about it, I became suspicious, so I called the police in Lumberton to check on the murder weapon. I explained about my two stolen 30 caliber rifles and gave them the serial numbers. Yes, they had the guns and one had been used in the killing.

We have no plans for continuing the Youth Forum that was published in the October issue . . . at least not under the same byline.

I have promised to let Lin check on all employment applications for 73, even those on a short trial, in the future. If her intuition says no, no it is. I know when I am licked.

(continued on page 97)

Bill Hayes W2BSP
12 Schiller Street
Hicksville L.I. NY 11801



W2BSP's collection of "cavities."

Single Sideband AM-FM Modulation System

Much has been said pro and con about single sideband in its present form. It is an admitted fact that SSB takes up far less of the radio spectrum than AM or FM. Still when you tune in an AM or FM signal with a proper receiver there is a difference. With SSB as it is now, tuning the receiver is critical and stability of the receiver is very important. When the carrier is sent along as in AM or FM the tuning of the receiver is no problem.

Being an old time amateur and liking AM for so long, when SSB came along I could not warm up to it at all. I always liked to hear all that was going on even if it was on an adjacent channel, beat note and all. It was somewhat like being in a room with a lot of people talking at the same time with all the noise added. Today the adjacent channel is all monkey chatter which is almost as bad as the heterodynes. Sometimes you like to know what your neighbor is saying, good or bad. Tuning a few hertz off and not being able to understand, yet hearing the signal either nasal or guttural is not best for me. Also, how are we going to make use of this SSB in the UHF and microwave regions? You would need the stability of an atomic clock at both the transmitter and receiver. FM has made the deepest penetration into these frequencies. Narrowband FM is being used for most mobile communication, and many improvements have been made over the years.

By now I guess you can gather from the above that I am not happy with SSB as it is and I am not about to chuck the old AM rig that is gathering dust in the basement shack. I am dreaming about the ideal system where the carrier would be sent along with a bandwidth no wider than that required for a single signal the same as CW. If someone sneaks alongside I don't want to hear anything other than his own speaking voice.

So now, to get started and narrow things down, I decided to start playing around with filters. Crystal filters are excellent and everyone uses them, but I wanted a filter that I could tune. Just for kicks I decided to build around 30 mhz. Crystals having a fundamental at 30 mhz are pretty hard to come by, so I decided to investigate the resonant cavity type filter as they are quite easy to make. My first thought was the re-entrant type cavity, so I started to look for one. Down on Newbridge Road there is a water tank about 25 feet in diameter and 100 feet in the air. It looked like it would resonate at 30 mhz. This turned out to be wishful



A sight for sore eyes on the Long Island Expressway.

thinking as it was pretty solidly mounted and I assume that the water department would be a little reluctant to let me borrow it for my experimenting. There is one in Garden City that is nearly round and the spherical type is known to have a Q of around 53,000. Well my hopes started to shrink and I finally succumbed to a smaller cavity like a 55 gallon drum. It was quite a sight seeing my little Bianchina 500 Fiat going down the highway with a 55 gallon drum lashed on the back. I ended up with quite a collection – three 55 gallon, one 30 gallon and one 14 gallon.

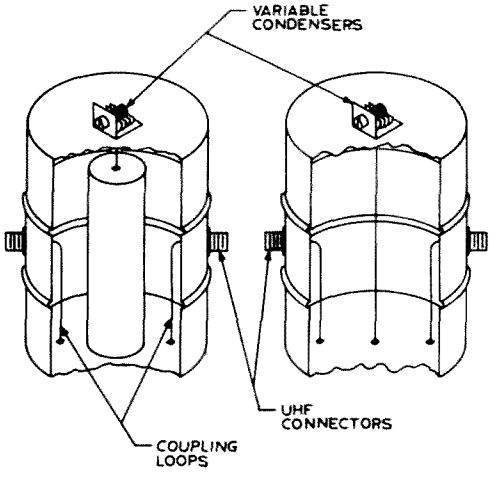


Fig. 1. Drum cavities.

I experimented with two types of re-entrant arrangements. One was made as shown in most textbooks, with a large re-entrant post and capacity loaded and the other with a single wire through the middle of the drum as a re-entrant element. Both of these cavities had a self resonant mode around 200 mhz. With a 100 pf variable capacitor, resonance at 30 mhz was found at about 65 pf. The cavity with a single wire as the re-entrant element had a higher self-resonant frequency as it required less capacity loading.

With the equipment in the shop it was impossible to make accurate Q measurements; to make even comparison measurements a good VTVM was needed, so I had to tap the piggy bank for a VTVM kit. I found this to be a very worthwhile investment and every ham shack should have one. Making comparisons of the characteristics of the two different type cavities showed that the one as shown in the textbook with the large re-entrant element had very little insertion loss, but did not have as sharp a band pass as the single wire job. The size of the coupling loops into the cavities was arbitrarily chosen and no great attempt was made to get a perfect impedance match to both input and output.

There are many things one can do to improve the Q of cavities, such as silver plating the inside or changing the shape and, for stability, temperature control or use of materials unaffected by temperature, etc. Considerable research on resonant cavities has taken place and by searching into past publications one can learn a lot. I was anxious to put them to use and, as far as the other sizes (30 and 14 gallon drums) were concerned, my research ended by finding resonance using the single-wire center element. The 30 gallon drum resonated around 40 mhz and the 14 gallon at 200 mhz using a 50 pf variable capacitor.

Not having a stable signal source on 30 mhz, I decided to build a transmitter that would have a 30 mhz output and when finished with my experimenting, successful or unsuccessful, I would at least have a usable rig on 10 meters. The rig would be FM and as stable as possible.

Having many old-fashioned tubes kicking around, I decided to build a rig as described in an old Radio Handbook (Editors and Engineers Limited. Eighth Edition). The tube lineup is a 6N7 audio amplifier, 6SJ7 reactance modulator, 6F6 electron coupled oscillator, 6K8 oscillator-mixer, and a 6H6 discriminator.

Starting with broadcast components in the electron coupled oscillator, the first frequency is 1.1725 mhz with a 2.345 mhz output. A tripler multiplies the frequency up to the 7 mhz frequency and some of the output signal is mixed with a crystal controlled oscillator. The output of the mixer produces a 465 khz signal, which is fed into a discriminator, thus producing a dc voltage that is used to stabilize the electron coupled oscillator.

Another output of the 7 mhz tripler is then fed into doublers that multiply the frequency up to 30 mhz. (Modern tubes were used for this.) The signal ended up with a 6AQ5, giving enough output to light a small neon. I encountered the usual parasitics and other things and had to back-track many times. Also, listening to the 28 mhz signal, I found it to have considerable 60 hertz hum with no audio going into the reactance modulator. The electron coupled oscillator called for a coil in the filament lead of the 6F6, and the AM broadcast frequencies require quite a few turns. There was a filament voltage drop and, with low voltage on the filament and ac in the coil, some modulation of the carrier was taking place. I decided to put dc on this filament; with good filtering the hum on the carrier decreased substantially.

Now I had an FM signal generator ready for the drums. I connected the output to the input of one of the drums and, using a sensitive meter with a crystal rectifier, I was able to observe the changes of reading as I tuned through resonance. The single wire re-entrant drum tuned very sharply and I was pleased. When tone modulation was applied, the reading went down just as it should. Using an on-off tone at about 2500 hz I found I could tune to both the upper and lower sidebands. I also found that I could get wideband modulation and

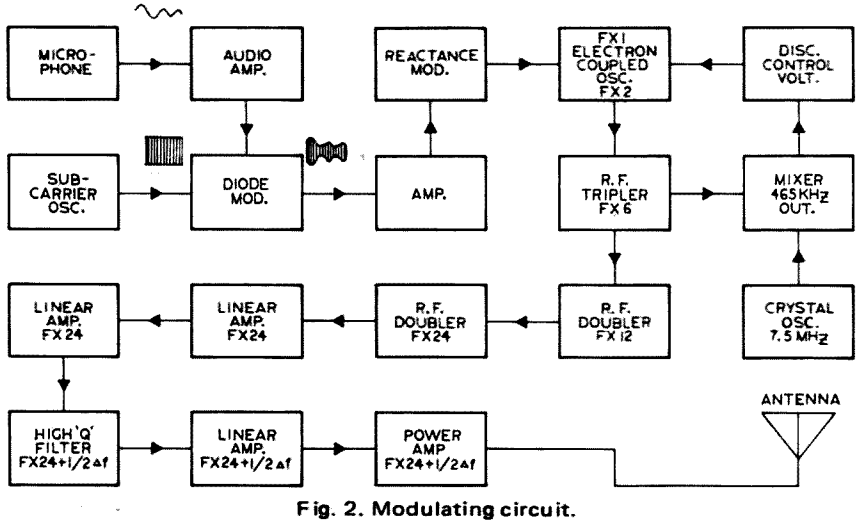


Fig. 2. Modulating circuit.

detected sidebands as much as 200 khz away from the center frequency of the FM signal.

I also found that I could peak the final amplifier to the upper or lower sideband and get an increased signal reading depending where resonance of the drum was tuned. The maximum sideband signal also varied with changes of audio level or deviation. The tone of the on-off oscillator was good when I listened on my old AM receiver and it was quite easy to locate the carrier center with no audio. With very little shielding of the chassis and the bottom plate off there was plenty of rf floating around the shack.

Well now, what will happen with voice and music fed into the system with all this deviation and how much intelligence will get into the filter? I coupled a microphone into the unit and turned up the gain and listened on the AM receiver. All that I could hear was a lot of pops of the high level audio peaks and it sounded very similar to our present sideband without the carrier added. By increasing the deviation there were a greater number of pulses due to more rf getting into the filter, but it sounded pretty awful. None of the low amplitude audio was getting to the filter and at this point I thought of using volume compression and clipping. I saw an article in 73 on a compression amplifier and immediately built one. The output of this was fed into the unit and after a few more days of tuning, testing, and listening to a little less awful sounding signal I proceeded to the local liquor store and bought a bottle of scotch and drank it. This didn't help so I decided to try clipping. I incorporated it in the compression amplifier, using a couple of diodes for the clipping. Now, this made an improvement and with all the distortion created by very heavy clipping I finally was able to understand voice modulation. Music sounded like 2000 cats on an equal number of different sized tin roofs.

After analyzing the situation I found that those low amplitude audio inputs would never make it, or would only when all others were deviated into the microwave region on the upper sideband or back into the audio range on the lower sideband. Then there wouldn't be much left anyway because the carrier would be spread out as if hit by an atomic bomb.

Those low amplitude audio signals needed a little push. Why not introduce a subcarrier that would push those little signals out to the filter, just far enough that they could be heard? The frequency of the subcarrier would be above the audio range and would not be heard. I started immediately to build an oscillator out of transistors and ended up with an oscillator on about 35 khz. I fed this directly into the grid of the reactance modulator mixing it with the audio. Making all the necessary adjustments I listened, but those low audio signals just didn't come through. I then decided to look at the audio going into the reactance modulator on an oscilloscope; sure enough, it was riding up and down with the carrier and not modulating like old fashioned AM should. We needed a better arrangement. I decided to put a diode modulator to work and get good AM modulation of the subcarrier.

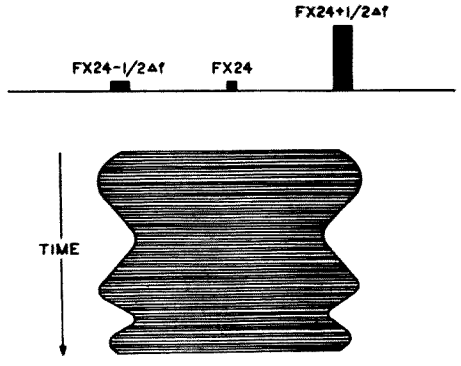
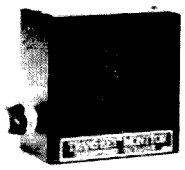


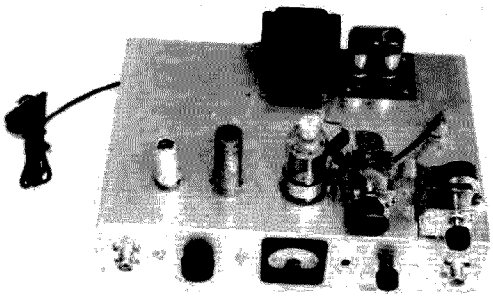
Fig. 3. Carrier, sub-carrier & audio modulation.

This arrangement made a tremendous improvement—so much that not only could I understand what a person was saying but I could also make out the music. The AM receiver I have was not up to receiving this type signal too well, so I needed something a little better. I found an old 30 mhz i-f strip out of a surplus radar in my junk and started to work on it. The strip needed a going over as one of the rf amplifiers oscillated when plate voltage was applied. I installed a ratio detector after the last rf stage and after a


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few additional problems I got the strip to work. I lowered the supply voltage, as the strip had quite a bit more gain than I needed to make tests. Using a small transistorized audio amplifier and speaker, I started to listen to the output of the filter. It sounded pretty good.



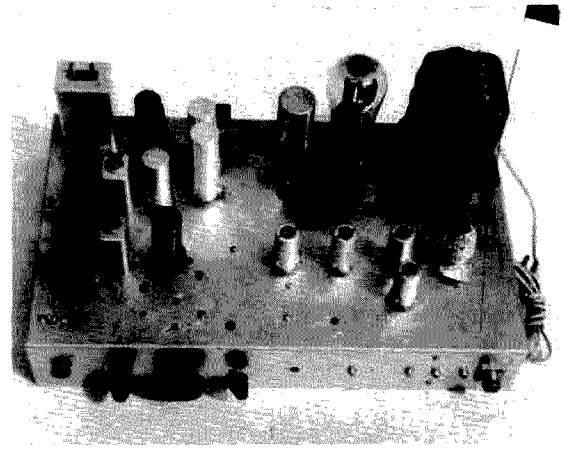
Linear amplifier.

Now what would happen if the output of the filter were coupled into a final linear amplifier? I decided to build a linear amplifier with a circuit using a 12BY7 driving a 6146. This linear amplifier was built on a separate chassis using two well-regulated power supplies, one low voltage and one high voltage.

After the usual problems with neutralizing and parasitics I found there was insufficient gain and another stage of amplification was required. Also I might point out that for the filter I now had two 55 gallon drums hooked in tandem. This introduced considerable insertion loss and the amount of power output was small, but contained the sharp band-pass characteristics that are needed. Using a 6AU6 to drive the 12BY7 brought the filter output up and drove the power up to a good level. With this additional power I was now able to take the receiver some distance from the equipment and listen to the quality. After listening I became very encouraged and was pretty well convinced that I had a different means for getting a sideband signal that would be pleasant to listen to.

In that this type of modulation as far as I know is not on the FCC list I have not put the system to test on the air. With the proper FCC approval I will give it a try, but in the meantime will continue to use the dummy load for tests.

In that the first unit constructed grew like Topsy, future plans are to build another chassis using better components and newer layout. There is considerable room for experimentation with the system and I also have plans to try using two arrangements having two different subcarriers so as to get a compatible stereo output. This will require a different or double detection receiver.



Main chassis.

Many improvements can be made for band switching with tunable filters. One disadvantage for amateur use is that the filter is at the fundamental frequency transmitted and it has to be good as it is the frequency determinant and must be stable.

In that the system contains both AM and FM and a filter I guess that the best name for it would be Frequency Aperture Modulation, or FAM.

. . . W2BSP ■

Leaky Lines

Writing a monthly article for a magazine like this is not a lead-pipe cinch. It can be sheer drudgery, tedious and monotonous, because of the limited subject matter. By precedent it has been established, more or less, that publications oriented toward specific activities should confine themselves to those alone.

One's intellect, however, fairly shrieks for variety, above all. For the disciplined, principled view, which always characterizes small and large crusades, demands constant iteration and reiteration. The moral obligation to maintain a concentrated pressure in order to effect a desired change (and it *is* an obligation) demands allegiance to the idea . . . completely and wholeheartedly. Yet, there do exist other things, other matters of fascinating interest, even though they may be less appropriate, or may appeal to be lighter, when weighed in the scale of comparative importance.

It is sometimes necessary to take a look around and consider these lighter topics, in order to preserve a certain quotient of balance in the total equation of existence. For, one-sided, overfervent, hyperintense crusades create one-sided, overfervent, hyperintense bores . . . people who, despite the correctness of their views, succeed generally only in repelling the very ones they are most anxious to convince and convert.

Just to demonstrate that three prohibited examples out of this group, all of which have been pronounced "taboo," may be discussed without provoking anything more alarming than the gray matter, I wish to concern myself with them in this installment of my personal journal. For many years the timid and timorous have studiously avoided any open dialog upon these matters, lest they offend the sensibilities of that huge mass of shadowy, faceless and nameless creatures called "the public."

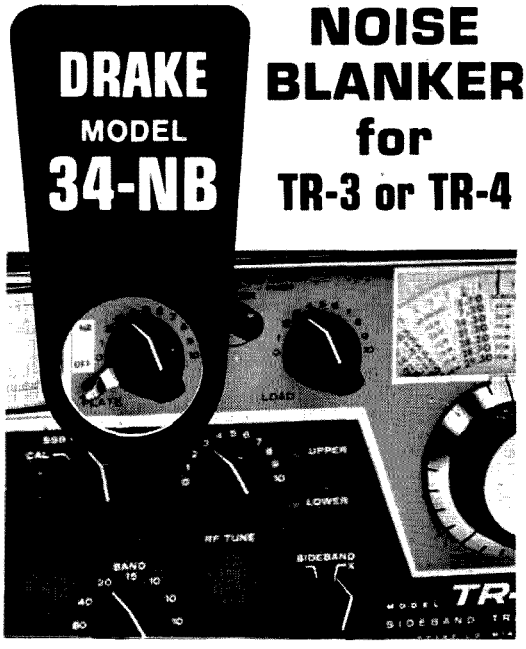
But this "public" is not merely an amorphous glob of inorganic goop, without volition or the ability to distinguish between common sense and idiocy. The 'public" is composed of individuals, in each of whom resides, if only dormantly, the intelligence to determine for himself the dimensions and limits of decency, propriety, and virtue.

And so, despite the upraised hands and horrified tongue-clucking of all the alarmists who ceaselessly warn of impending doom and disaster, I shall make a few observations and speculations concerning these three unmentionable subjects: Politics, Religion, and if you'll pardon the expression, Sex!!!

Now this, as if you didn't know it, is an election year. And in such periods we seem always

(continued on page 93)

Kill ignition noise
and other strong impulses
with a



Unlike the usual noise clippers or limiters, the 34-NB is an advanced noise blanker which actually mutes the receiver for the duration of the noise pulse. Between noise pulses, full receiver gain is restored. (The receiver AGC is affected only by the desired signal strength, not by the noise at the antenna.) Low level signals masked by noise impulses without the noise blanker can be copied when the blanker is used. The 34-NB is a must for the mobile operator.

HOW IT WORKS . . .

A noiseless electronic series switch is inserted at the output of the receiver mixer. This switch is operated by the output of a special receiving circuit which is tuned to the 9 MHz IF with bandwidth of 10 kHz. The switch opens for noise impulses but closes to allow the signal to pass.

The kit consists of these main parts: 9-NB board (composed of 17 transistors, 4 diodes and circuitry), NBK board, capacitor assembly, switch assembly, lever knob, and miscellaneous hardware.

Available only as a factory installed accessory. Includes noise blanker and transceiver alignment.

Model 34-NB $129.00 Amateur Net

At your distributor or write to

R. L. DRAKE COMPANY

540 Richard St., Miamisburg, Ohio 45342

The Transceiver Companion

Peter A. Lovelock W6AJZ
235 Montana Avenue
Santa Monica CA 90403

The transceiver companion is not just another control console; in fact, its application isn't limited to transceivers, and it might well find a place with any receiver-transmitter combination. It started out as a desire to integrate all the associated accessories which surrounded the transceiver in the corner of our apartment living room.

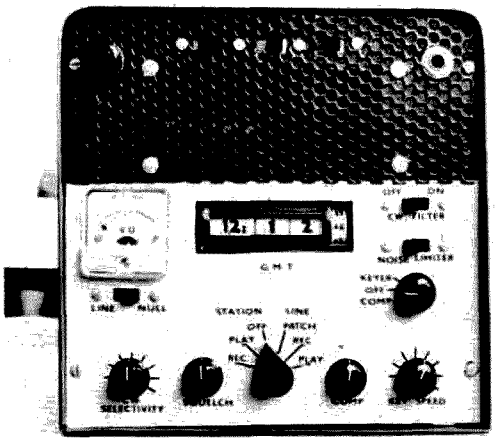
What with a compressor preamp, electronic keyer, phone patch, tape recorder, CW filter, clock and speaker with associated cables, the corner was getting messy and the XYL unhappy. Besides, there was a problem of plugging and unplugging for each mode of operation, and the tape recorder would be more useful if . . . . . !

Thus the transceiver companion evolved to integrate the necessities of a fixed station transceiver, with the one exception of the tape recorder itself. But it took care of utilizing the recorder for various purposes without touching a connector.

Actually this article presents ideas for consolidating the ham station accessories adaptable to the individual constructor's needs. My companion was designed to provide associated functions for my Galaxy V Mark 2, though with a mind to eventual equipment replacement, and the flexibility to work with something else.

So if you use some other equipment and your operating habits dictate other accessories than described, you may well be able to build a companion of your own. It may not even look the same, for you will likely as not want to utilize a housing to match your other equipment. And how many hams exactly copy any construction article?

The heart of the transceiver companion's flexibility is the use of plug-in, computer-



type boards, for all the transistor circuits incorporated. You can buy such boards ready made, or build them yourself. They permit great ease for trying out different circuits, or substituting that better one when it comes along with a minimum of construction change. And they are real great for testing and troubleshooting, or incorporating the occasional modification.

Thus, the companion isn't a static piece of equipment doomed to eventual obsolescence.

Besides the transistorized circuits, other accessories are incorporated in more conventional form. Right now my transceiver companion incorporates the following which, apart from the tape recorder, mike and separate power supply, is everything I use with the transceiver:

(1) speaker, and headphone jack.
(2) low-pass speaker filter to eliminate SSB monkey chatter.
(3) phone patch/tape recording and playback facility with selectable mode.
(4) digital clock.

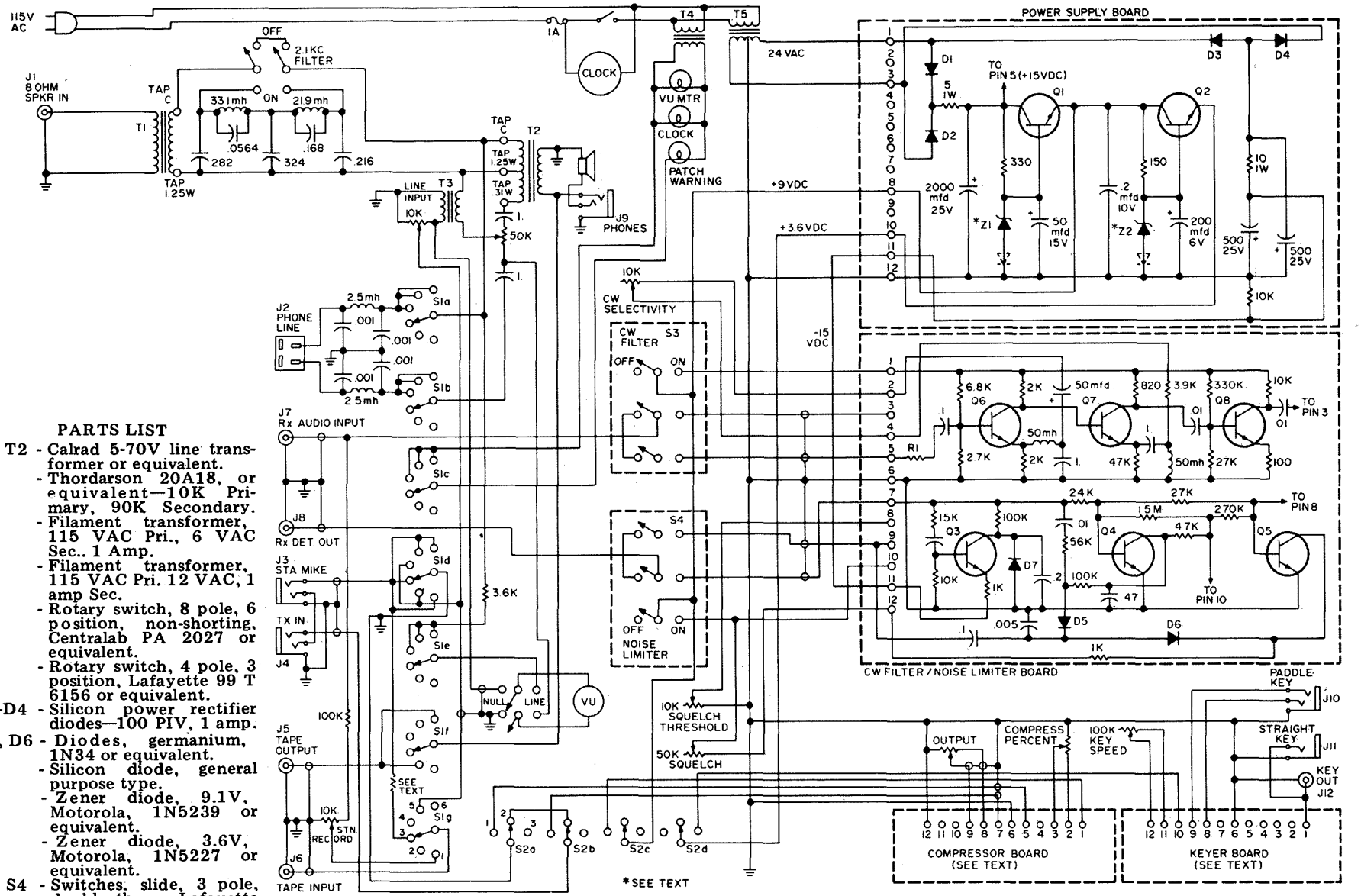


Fig. 1. Schematic.

PARTS LIST

- T1, T2 - Calrad 5-70V line transformer or equivalent.
- T3 - Thordarson 20A18, or equivalent—10K Primary, 90K Secondary.
- T4 - Filament transformer, 115 VAC Pri., 6 VAC Sec.. 1 Amp.
- T5 - Filament transformer, 115 VAC Pri. 12 VAC, 1 amp Sec.
- S1 - Rotary switch, 8 pole, 6 position, non-shorting, Centralab PA 2027 or equivalent.
- S2 - Rotary switch, 4 pole, 3 position, Lafayette 99 T 6156 or equivalent.
- D1-D4 - Silicon power rectifier diodes—100 PIV, 1 amp.
- D5, D6 - Diodes, germanium, 1N34 or equivalent.
- D7 - Silicon diode, general purpose type.
- Z1 - Zener diode, 9.1V, Motorola, 1N5239 or equivalent.
- Z2 - Zener diode, 3.6V, Motorola, 1N5227 or equivalent.
- S3, S4 - Switches. slide, 3 pole, double throw, Lafayette 99 T 6166 or equivalent.

(5) transistorized noise limiter and squelch.
(6) variable selectivity audio amplifier for CW operation.
(7) electronic keyer.
(8) microphone compressor/preamp.
(9) power supply for transistorized circuits.

The entire unit is housed in an 8 inch x 8¼ inch x 8 inch cabinet, taking up just 1/3 cubic foot of space.

Fig. 1 shows the complete schematic of my transceiver companion, and the following is a description of the elements enumerated above:

Speaker

A 6 inch by 2 inch, 8 ohm voice coil speaker was selected because of the excellent response range and convenience of fitting this configuration into the available panel space. This type speaker is available from a number of sources (including a replacement for several popular brand table model TV sets). However, TV manufacturer replacements run around $7.50, while imported makes cost from 89 cents to $1.98. Usually the lower the price, the smaller the magnet and the lower the efficiency. Some imported makes have 3.5 ohm voice coils, requiring use of the 4 ohm tap on T2. (See recommended parts list.)

Low-Pass Speaker Filter

The switchable 2.1 khz low pass filter is a Chinese copy of that described by W3NQN (*QST*, Technical Correspondence, November, 1967). Transformer T1 elevates the transceiver output impedance to the 500 ohm impedance of the filter. T2 matches the filter to the 8 ohm (or 3.5 ohm) speaker. T2 also serves double duty as a component of the hybrid phone patch circuit described below.

This excellent filter circuit provides a maximum attenuation of -60 db at about 2.6 khz, and no less than -40 db at all frequencies above that. It is considerably superior to constant K and m-derived filters in the sharp cutoff above 2.1 khz, which knocks out high pitched "monkey chatter" and heterodynes without affecting speech intelligibility.

The filter on-off switch is therefore not essential as it may be left permanently in circuit. However, since I anticipated using the speaker for other monitoring purposes, the switch was included to permit optional full response range. In addition, it provides a convincing demonstration of the effectiveness of the filter, which has to be heard to be believed.

The filter coils are made from surplus 88 mh toroids by removing turns until the exact values are measured on an impedance bridge. Similarly, the odd capacitor values are built up from standard value units in parallel and measured on the bridge to obtain the precise values shown. Not every ham has possession or access to a high precision bridge, unfortunately. Use of approximate values will result in degradation of performance from the optimum. Therefore, I can't overemphasize the value of borrowing a bridge, or prevailing upon some engineer or technician friend who has one at his disposal, if you plan to use this filter. The results will be worth the effort.

Digital Clock

This was obtained by extricating the works from the plastic case of my former desk clock (Tymeter twenty-four hour clock, Lafayette catalog 40 T 9102). The entire clock movement is assembled on a casting, mounted by two screws to a bottom plate. The plate was removed and discarded, and the tapped holes in the casting utilized to mount it to the companion chassis foundation. Two miniature pilot lamp holders were attached to the numeral mask to provide illumination.

Phone Patch/Recording Switcher

The phone patch is a duplicate of that designed by Katashi Nose, KH6IJ ("An Inexpensive Hybrid Phone Patch," *73*, November, 1965). This circuit permits the use of low-cost transformers and a 50k balancing pot, with impedances widely in variance with the conventional 600 ohms. This results in fantastic losses, but as KH6IJ pointed out, the loss in gain is appropriate when matching a 0 db level phone line to a -55 db mike input. In fact, the "imperfections" of this circuit serve to reduce hum and rf susceptibility, and it works like a charm at a fraction

of the cost for the components of a high grade circuit.

As mentioned above, T2, which is a center-tapped transformer providing two arms of the bridge, also serves the dual function of matching the output of the low-pass speaker filter to the speaker. When this was tried experimentally, it was feared that switching the filter would cause a change in the null balance, but this proved unfounded, and T2 serves its dual role beautifully.

T3, the two 1 mfd capacitators and the 10k potentiometer (TX input level), make up the balance of the patch components. A refinement to the original circuit was the addition of a VU meter which, by means of a DPDT slide switch, can be selected to read transmitter input level for null adjustment (null position) or output level to the phone line (line position). I personally consider the use of a VU meter essential to prevent feeding too high a level to the phone line, which is all too easy if "ear" measurement is depended upon.

Null adjustment is described at the end of this section.

J7 and J8 provide for permanent connection to the mike input and speaker output of a suitable tape recorder. (I use a small transistorized recorder, with high impedance mike input, 8 ohm speaker output.) Phone patch/recording/playback mode switching is provided by S1a-g which is a 4 deck, 8 pole, 5 position, nonshorting rotary switch wired to provide the following functions:

Position 1 - Record from receiver.
Position 2 - Playback to transmitter.
Position 3 - Off (usual position during normal station operation).
Position 4 - Phone patch.
Position 5 - Record from phone line.
Position 6 - Playback to phone line.

While position 3 is denoted as "off," it will be noted that the station mike is connected to the tape recorder input in this position. Therefore, activating the recorder in position 3 will permit recording of transmissions made. If PTT can be deactivated, the station mike can be used for making any recording, such as directional CQs, which can then be played back as often as required to the transmitter input by switching the mode switch to position 2. Alternatively, another station's transmission may be recorded (mode switch in position 1) and then played back for his edification (position 2) or held over for later telephone relay to some third party (position 6).

The mode switching permits flexible utilization of the tape recorder without having to plug or unplug a single connector for any mode.

With a high-impedance recorder input, no loading or gain loss from the station mike is experienced when simultaneously transmitting and recording with mode position 3. However, some transistorized recorders have input impedances which are intermediate, even though they function with a crystal mike. Such recorders may load the mike line and cause significant loss of gain to the transmitter input. In such cases a resistor of 50k to 250k should be inserted in the wire between sections d and g of S1, until no noticeable loss of level to the transmitter can be observed. Tape recorder input level can be compensated by its own gain control.

In mode positions 4, 5, and 6, all of which involve connection to the phone line, section c of S1 activates a warning light mounted in the top left hand corner of the front panel, to remind the operator to return the mode switch to a nonphone line position at the conclusion of this type of operation.

Two 10k pots mounted at the rear of the companion provide preset level adjustment for station receiver output to the recorder, and phone line input to the transmitter and tape recorder.

To adjust the hybrid phone patch balance, first call an obliging friend and have him hold the line. Switch mode to position 4 and VU meter to *line* . Feed a steady signal from the receiver (such as the beat note from crystal calibrator, tuned to approximate a 1 khz tone), and adjust the receiver gain control for a VU reading of 0 db. Switch VU meter to NUL and slowly adjust the 50k balancing pot for null (zero) reading on the VU meter. This first null may appear somewhat broad. Actually the null position

of the pot is quite sharp, but the null is about -40 db, while the VU meter range is limited to about 25 db. It will now be necessary to temporarily crank up the receiver gain in order to feed enough level to the meter to find the exact null adjustment. This must be done as quickly as possible since it means feeding more than the normal level to the line. Once set, the null pot requires no further adjustment unless the companion is connected to a different line—such as when changing QTH. However, it's worth rechecking once in a while, in case the company has modified something at the other end of your line which would affect the balance.

The VU meter must always be switched to line position when using the phone patch, and the receiver gain control adjusted so that VU meter readings do not exceed 0 db on voice peaks. If the switch is left in null position during operation, the VU meter will load the transmitter input and result in severe loss of gain from the phone line. However, during normal, nonpatch operation the null position may be used to provide visual monitoring of the receiver output, since the hybrid circuit is unbalanced when the phone line is disconnected. Thus, actual signal versus noise reports may be given to stations in addition to the traditional S-meter readings. The meter is automatically disconnected in the line position, when the mode switch is in position 1, 2, or 3 to prevent possible damage from high signal levels at the unloaded phone-line switch connections.

In the event your transceiver doesn't permit taking audio from the detector stage, as required by J4 in Fig. 1, an alternate circuit which will permit recording from the receiver is shown in Fig. 2. This involves the addition of a small transformer, T6, with an 8-ohm primary and 500-ohm secondary impedance to match the tape recorder output to the patch line terminals when the mode switch is in position 2.

Noise Limiter and CW Filter

In order to use the noise limiter and CW filter it is necessary to be able to take audio output directly from the product detector and feed input to the audio amplifier of the

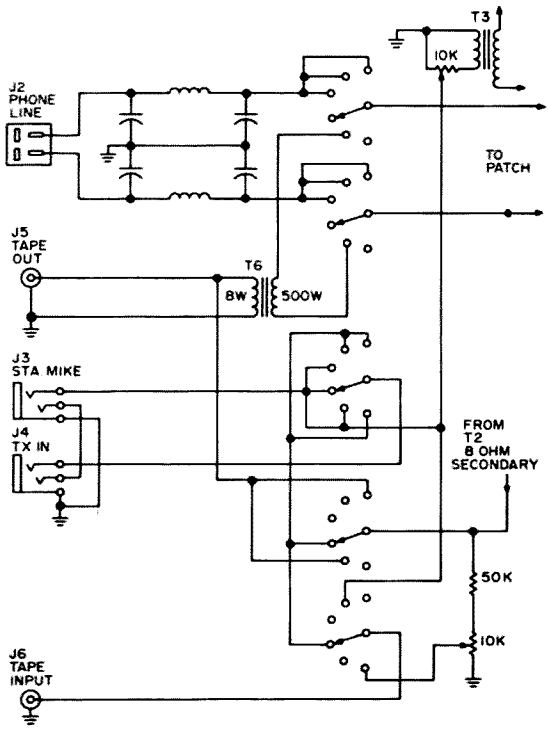


Fig. 2. Alternate circuit for station recording and playback. T6—Miniature transistor output transformer, 600 ohm pri, 8 ohm sec.

transceiver. The Galaxy V Mk2 and the Mk3 transceivers have such a provision built in to accommodate an audio filter manufactured by Galaxy. If your equipment has no such provision it can easily be incorporated by mounting a dual RCA type phono jack on the rear of the unit and wiring the detector output to one jack and the amplifier input to the other, using shielded cable. If you don't care to make such a modification you obviously can't make use of this section.

Both noise limiter and CW filter are constructed on a single plug-in board (see construction section).

The noise limiter is a transistorized version of the popular TNS circuit, comprising Q4 and Q5, and was adapted from a circuit by Tom Kneitel K3FLL ("103 Simple Transistor Projects," John F. Rider Publishing, Inc.). Q3 is an audio derived agc circuit furnishing fast attack, delayed release negative bias, to replace the more common carrier derived avc from an AM detector which this circuit requires to "gate" the squelch action. As with its tube predecessor, this circuit provides a squelch feature by varying the load resistor value in the collector of Q5. The load resistor is a front

panel control, 50k potentiometer labeled SQUELCH. The 10k pot connected to the base of Q5 is for preset adjustment of squelch threshold, and is mounted on the rear bracket. Setting of this control depends upon the exact characteristics of the transistors used, and the input signal level to some degree. To adjust it with signal applied from the receiver, the squelch threshold control should be advanced from zero circuit resistance to a point where no further increase in signal level is observed. Any further advance of the control will result in overdriving the transistor bases with resultant distortion and degradation of noise-limiting action. The adjustment is best made with random noise, and setting slightly below the point of maximum signal may improve noise limiting. At the optimum setting of the squelch threshold control, squelch action will occur at about the midpoint setting of the front panel squelch control.

It should be noted that, for the circuit constants shown, Q4 and Q5 and the diodes D5 and D6 *must* be germanium types. Silicon types will not function with the resistor values shown. Q4 and Q5 may be any audio-type, germanium NPN transistors with an h_{FE} of about 100.

The selective CW filter comprised of Q6, Q7, and Q8 is adapted from a circuit by Jim Fisk W1DTY (*73 Transistor Circuits*, published by 73 Magazine). Q6 and Q7 have a controllable feedback loop between their emitters, which is correctly phase shifted by the series tuned circuits in parallel with the emitter resistors, so that feedback takes place only at a frequency determined by the tuned circuits. The 1 μf, 3v ceramic capacitors and 50 mh coils used in my unit provide a resonant frequency of 700 hz. These values were used because they were available, but other combinations of L and C may be substituted, providing they resonate at a desired audio frequency. However, as the value of L in increased so is the impedance of the circuit, and the feedback control potentiometer will also have to be increased.

The 50 mh coils I used are surplus miniature shielded toroids, and regardless of the value of the coils, toroids are strongly recommended to avoid stray coupling, which will degrade the selectivity of this circuit. The use of high value ceramic capacitors requires matching the values of the components used to ensure that both circuits are resonant at the same frequency, since ceramic capacitors have wide tolerance ranges. If test equipment is not available to match the capacitors, you can try padding each capacitor with smaller value capacitors until regeneration (audio oscillation) occurs with the lowest setting of the 10k potentiometer.

The CW selectivity control varies the amount of feedback between Q6 and Q7 and thus changes the bandwidth. At a point just before oscillation occurs, selectivity becomes extremely sharp with the characteristic ringing of a crystal filter, so that only the slowest speed CW can be copied. The 3.9k resistor in series with the selectivity potentiometer should be decreased or increased experimentally until the circuit is just on the threshold of oscillation when the selectivity control is advanced fully clockwise (zero resistance).

Resistor R1 is provided to attentuate the output of the product detector, which in the case of the Galaxy V was too high for the input of Q6. The value will have to be determined experimentally for the receiver used, but in the case of the Galaxy it is 100k.

The original Fisk circuit included an emitter follower ahead of Q6 to provide input isolation. This stage was found to be unnecessary with the high input level from the Galaxy V product detector, since the 100k series attenuating resistor required to drop the level to Q6 furnished a sufficiently high input impedance to prevent loading the detector stage. If this circuit is to be used with equipment requiring an isolated input, the emitter follower input circuit may be required, and Fig. 3 shows this optional circuit.

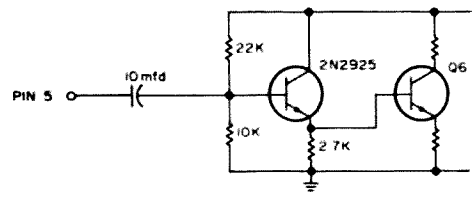


Fig. 3. Alternate input emitter-follower stage for CW filter.

Since the output of Q7 across the 820 ohm load is quite low, Q8 is a simple stage of gain to raise the level to that required for the transceiver audio input.

Jacks J3 and J4 connect to the product detector output and audio stage input via shielded cables. Both the noise limiter and CW filter circuits are switched in and out of circuit by two 3-pole double-throw slide switches mounted on the front panel. One section of each of these switches provides the +9v regulated power required by both circuits. It will be noted that the switches are wired in combination so that the noise limiter is ahead of the CW filter when both are used simultaneously. This is important, since high impulse noise peaks, such as ignition, switching transients, etc., can cause extreme ringing when the CW filter is adjusted close to maximum selectivity. Removal of such pulses can make possible the copying of weak signals through QRM which would be rendered intolerable by high noise impulses.

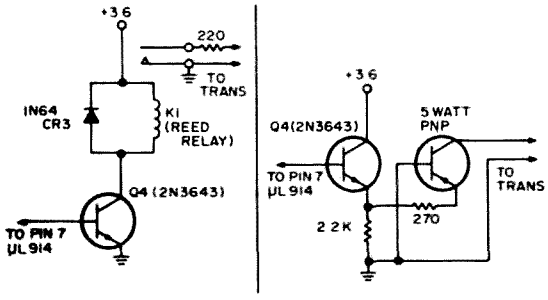


Fig. 4. Power transistor switching output modification for K3CUW keyer.

Electronic Keyer

The keyer board incorporates the circuit of the Micro-TO Keyer by K3CUW (*QST*, August 1967, and *ARRL Handbook*, 1968). Consequently, the complete circuit is not included on the schematic, although external connections to the board are shown. The sidetone oscillator in K3CUW's keyer was excluded since my transceiver has built-in provision, but the board has plenty of room to include the oscillator if required. The only other deviation from K3CUW's circuit was the use of a power transistor, instead of a reed relay, for direct keying of the transmitter. Fig. 4 depicts the incorporation of the power transistor to the Micro-TO Keyer. Just about any PNP 5 watt power transistor will function in this circuit, which is intended for grid-block or low power stage keying.

Compressor Amplifier

A number of circuits have been tried out on this board over the past year, and if you find a compressor useful in your operation, the bibliography may prove helpful. Unfortunately, for proprietary reasons the actual circuit now in use cannot be reproduced here but typical controls and connections to the board are included on the schematic.

Switch S2 is a 4 pole triple throw, nonshorting rotary switch, which switches in either the electronic keyer or the compressor amplifier. A single switch, with center position off, was utilized, since quite obviously simultaneous operation of keyer and compressor is never required. In the off position power is removed from both keyer and compressor, and the microphone is connected directly to the transmitter. When the switch is in keyer position, the microphone is disconnected from the transmitter to avoid unintended modulation.

Power Supply

The internal power supply, which furnishes all the voltages for the various circuits, comprises T5 and the regulated power board. T5 supplies 24 vac, center tapped ground to the board. A full wave rectifier consisting of D1 and D2 and associated filtering components supplies +15v to the voltage regulator circuits of Q1 and Q2. The regulator transistors furnish +9v and +3.6v respectively. The +9v supply is used for the CW filter, noise limiter and compressor circuits. +3.6v is used for the electronic keyer. Q1 and Q2 are arranged in series to give particularly stable regulation of the +3.6v, since the keyer current requirements are quite heavy during "key down," and any voltage fluctuation causes keying speed variation.

A word about the zener diodes Z1 and Z2 is in order. If 9.1 and 3.6 volt zener diodes are used in these positions, the output voltages will be the zener voltages less the 0.6 volt base to emitter drop in Q1 and Q2,

resulting in outputs of 8.5 and 3.0 volts. But zeners, like any components, are subject to tolerances so the voltages may be slightly higher or lower. While the +9v circuits aren't too critical, the +3.6v required by the keyer is, and should be adjusted as closely as possible. Too low a voltage will result in inability to obtain the lowest keying speeds, while the voltage should not exceed much over 4 volts to avoid damage to the integrated circuit components. Voltage adjustment can be attained by selecting zener diodes with high tolerance values. However, an easier method is to add forward biased silicon or germanium diodes in series with the zeners. The drop across the diodes will add to the zener voltage -0.6 volt for silicon diodes and 0.3 volt for germanium diodes. Having first assembled the circuits with the zener installed alone, measure the output and note the drop below the desired output. Then add silicon or germanium diodes as required to bring the voltage up to the proper value. Since the voltage drop across the forward biased diodes in constant within their current limitations, they have no effect upon the zener regulating capability. Both zener and regular diodes should be rated at 1 watt.

D3 and D4 provide full wave rectification to supply -15v unregulated, utilized by the age control circuit Q3 for gating the squelch.

+15v unregulated is also available at pin 5 of the board, though not currently utilized in my companion.

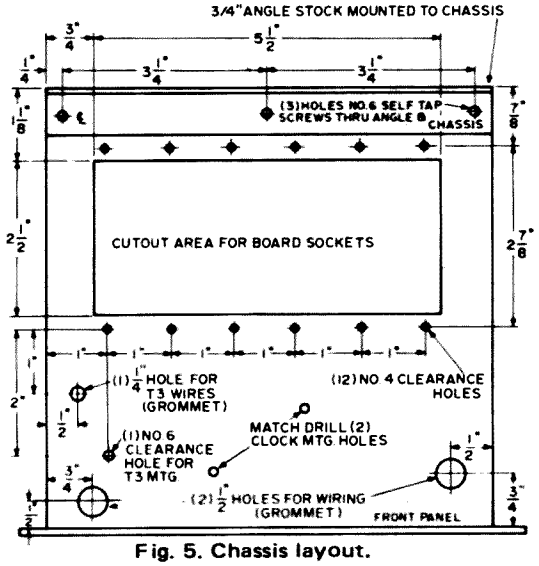
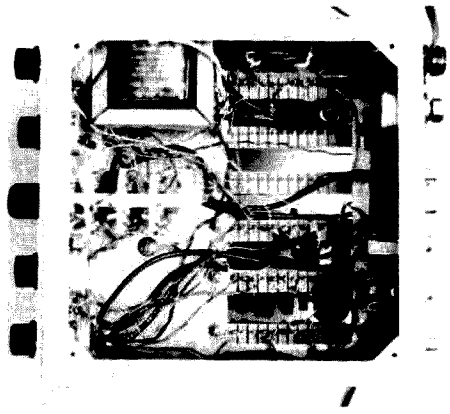


Fig. 5. Chassis layout.



Construction

For those who may want to duplicate my transceiver companion, **Figs. 5** and **6** show the chassis and front panel layouts with major cutouts and hole dimensions and locations. Not all component mounting holes are shown due to the likely substitution of components with dissimilar mounting requirements.

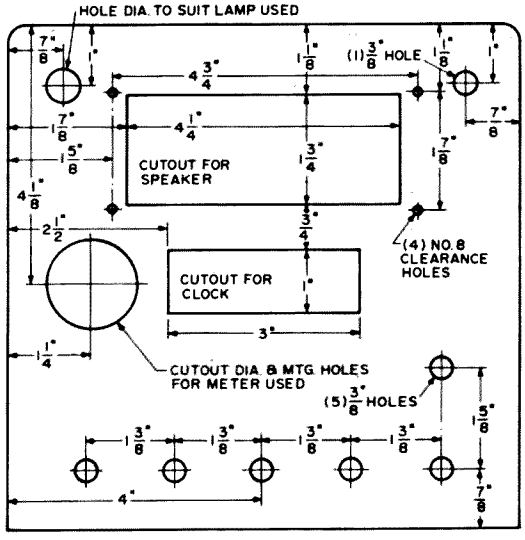


Fig. 6. Front panel major layout dimensions.

The front panel is part of the 8" x 8¼" x 8" cabinet, (Premier Compact Cabinet, Lafayette stock nunber 12 T 8436). Premier Metals manufactures this type of cabinet in various dimensions, for those who may have different requirements. The speaker grill was fabricated from a piece of perforated metal stock. Bottom part of the front panel was finished with two spray coats of light gray lacquer. Lettering and dial markings were applied with Letraset instant lettering, and the entire section given two finish coats of clear acrylic lacquer to protect the lettering. Top portion of the panel and the grill were

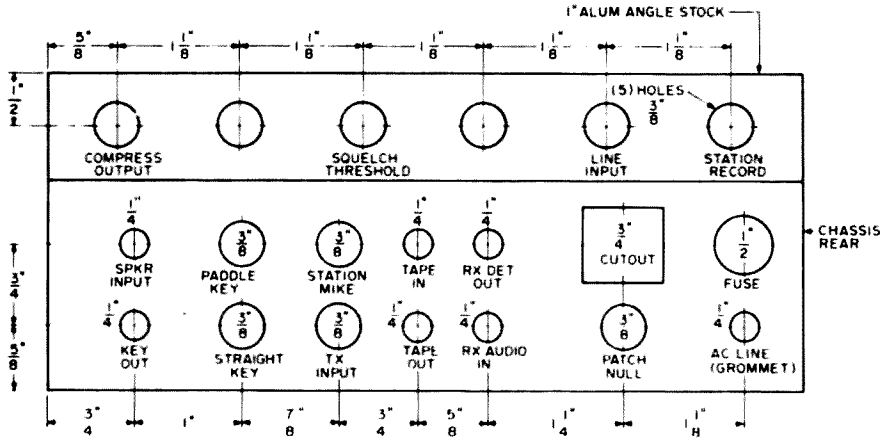
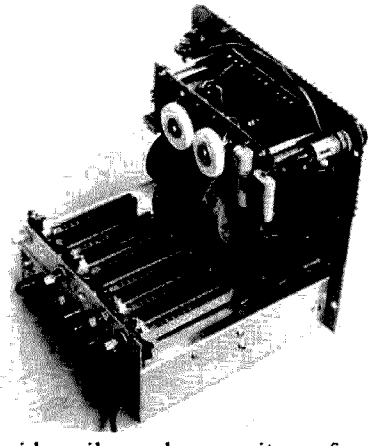


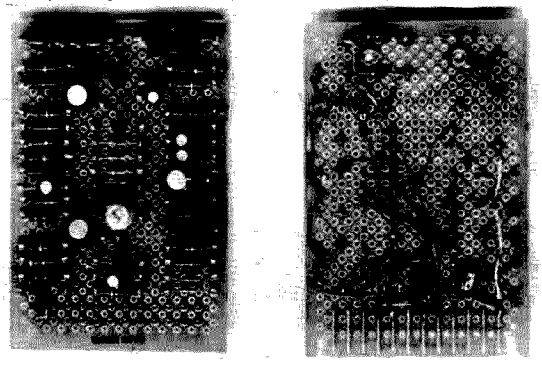
Fig. 7. Rear controls and connectors.

sprayed with two coats of black crackle, so that the speaker opening was "lost" in the overall black finish. The front panel is secured to the 7 x 7x 2 inch foundation chassis by the lower front control nuts.

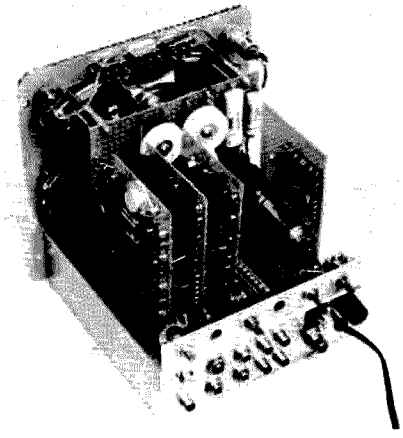


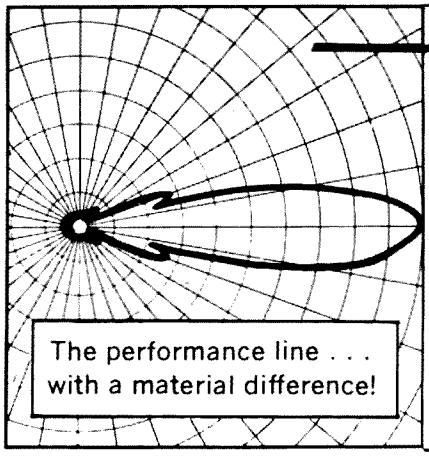
Toroid coils and capacitors for the 2.1 khz low-pass speaker filter, together with transformers T1 and T2, are mounted on a piece of perforated phenolic measuring 5½ x 2¼ inches. This board is mounted by standoffs to the front panel through the speaker mounting holes. The 2 inch standoffs are assembled from two 1 inch spacers commonly used for expanding three-hole binders, and available from industrial stationery stores. The spacers have 8/32 studs at one end and 8/32 tapped holes at the other. Hole ends of the assembled standoffs are used to secure the speaker to the front panel with ¼" 8/32 flathead screws. Stud ends of the standoffs are used to mount the board with 8/32 nuts.

Rear mounted "preset" controls are mounted on a bracket fabricated from 1" aluminum angle stock, fastened to the top-rear of the chassis. Fig. 7 shows locations of all rear controls and connectors.



The plug-in boards used for the transistorized circuits and power supply are Vector type 837 WE, 4¼" x 3". These boards are equipped with twelve connector pins. The WE suffix denotes epoxy glass material. While they are also available in epoxy paper material (type 837), the slight extra cost of the glass material is considered well worthwhile, since it is impervious to heat, permitting stripping and reusing boards for new circuits. Flea clips are used for mounting the components to one side of the boards, while interconnections are wired on the opposite side, as shown in the photo.





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Sockets are provided for six boards (sockets are Vector R612-1), with sufficient spacing to allow for component clearance. At present only four boards are utilized in my companion, leaving two vacant sockets for the addition of up to 50% more circuitry when the need arises.

Since a board-socket combination costs around $4.30, the budget-minded may want to make their own, which can be cut from suitable perforated stock sheet with .062 holes, and mounted to an appropriate male connector.

The sharp-eyed may note from the photos that two of the top-mounted panel slide switches are unwired. Well, together with the two unused Vector sockets, and the vacant control holes in the rear bracket, there is still room for expansion. And if additional front panel controls are required, with space getting at a premium, there are always those dual pots with concentric shafts, used in TV receivers.

Anyway, I think my companion will be around the shack for quite some time, even though it may pass through a continuing process of evolution.

. . .W6AJZ ■

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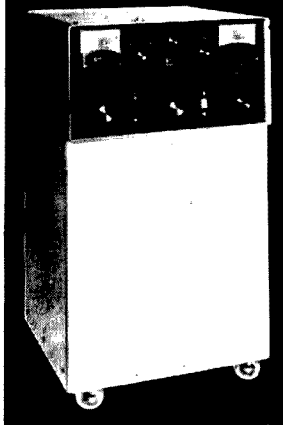
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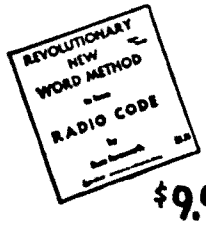
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It soon became apparent after building a rather complicated bench power supply that this was not the end of my power supply requirements. This complex supply provided 0 to 20 volts at 500 ma maximum with full regulation and overload protection and is ideal for development projects. Unfortunately, when it is being used on the "latest" project it cannot also be used to supply other devices in use in the shack. It was apparent that a small supply with choice of fixed output voltages (3, 6, 9, or 12 volts) and moderate current capacity (200 ma) would fill the need. Overload protection was desirable to ensure that an unexpected overload or short-circuit could not harm either the supply itself or other equipment. The specification for this new supply therefore became:

Output voltage:	3, 6, 9, or 12 volts (switched)
Output current:	200 ma maximum
Internal impedance:	Less than 5 ohms, preferably about 1 ohm.
Ripple:	To be less than 10 mv peak-to-peak.
Overload protection:	To reduce the output voltage to a low level in the event of excessive load currents or short-circuits on the output terminals.

A further requirement that the transformer used should not be a "special" meant that one with a 6.3 volt secondary would

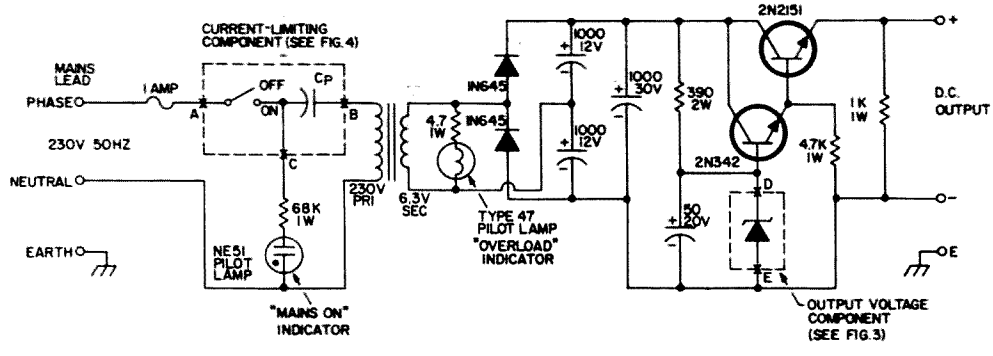


Fig. 1. Circuit diagram of the regulated power supply. The components in the dashed squares are simplified examples for purposes of explanation. A 230 volt supply is shown but the system can be easily adapted for 110 volts (see text). The "overload" indicator extinguishes when excessive output currents are drawn.

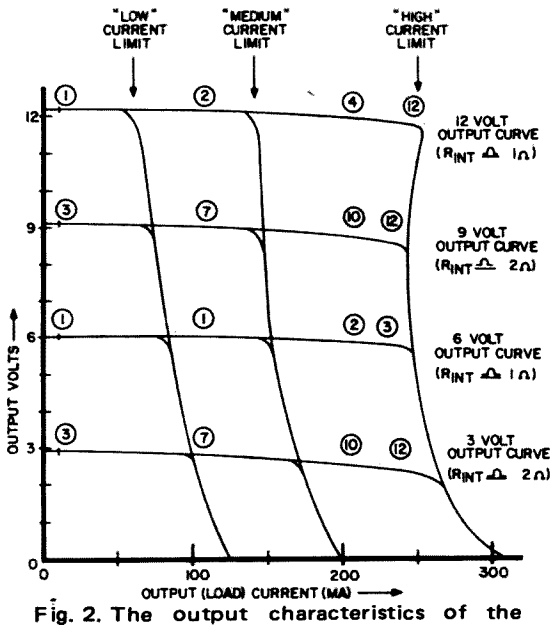


Fig. 2. The output characteristics of the power supply. Note that four output voltages (3, 6, 9 and 12 volts) and three current limits (at 50 to 100 ma, 130 ma, and 240 ma approx.) are available. The maximum currant limit may be increased (see text). The figures in circles represent peak-to-peak ripple voltages (in millivolts) at the load points shown, measured with an oscilloscope. Output impedance is about 2 ohms (at worst) on the flat part of the curves.

have to be used. This meant that some form of voltage doubler would be required to get a 12 volt output. This, however, represents a saving of two rectifier diodes over the four generally used in bridge circuits so in some ways is an advantage—provided the output ripple can be kept within the limits acceptable.

This, then, was the background to this project. The resulting circuit diagram is shown in Fig. 1 and the dc output characteristics shown in Fig. 2. Note that the input supply voltage is 230 volts at 50 hz. This is the domestic supply used in New Zealand and has been retained in this circuit in order to show the overload protection arrangements. Some component values will have to be changed when 110 volt primary transformers are used. As access to 110-volt 60 hz systems are just about impossible in ZL-land, details will be given later on the methods used to select component values for other systems of power distribution. It is hoped that some enterprising U.S. ham will investigate this with local components and write and tell this magazine about it, giving part numbers and component values.

The Circuit

The regulator circuit is basically a transistor series regulator with a zener diode as voltage reference. Two transistors are used in a compound circuit as cascaded emitter followers to ensure a low value of output impedance and to prevent any wide load variations from causing excessive changes to the zener diode operating conditions. A zener diode reference voltage is selected by means of switches to provide the output voltage required. The switching used is shown in Fig. 3. Two toggle or slide switches select the required zener reference diodes. Note that three diodes are used to provide four reference voltages.

The zener diode reference voltage has to be slightly greater than the resulting power supply output to allow for the base-emitter voltages of the two transistors. The transistors shown are NPN silicon types but many other types could be substituted, silicon or germanium. If PNP transistors are used, all diodes and all electrolytic capacitors will have to be reversed to provide voltages of the opposite polarity. If other transistors are substituted they should have as high a current gain as possible consistent with the current they are expected to handle.

I built the supply in an aluminum box 5 inches by 4 inches by 3 inches and the 2N2151 power transistor is bolted to the case but insulated from it by mica washers. A heat sink is not really required owing to the modest current output of this particular supply. More will be said about this later. Other constructional details will not be given

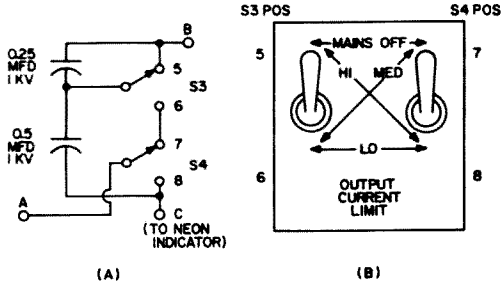


Fig. 3. The output voltage switching arrangements. Two SPDT switches select the required zener regulator diode. Switch positions in (a) are also shown in (b) which shows the panel labeling. Note that for 3 volts (as shown) the 3 volt zener is in parallel with a 6 volt zener—which of course will not be operating.

for there is nothing at all critical about the layout.

The 390 ohm resistor was selected to ensure that the zener diodes do not dissipate more than their 400 mw under any conditions. In fact they are considerably underrun. Other zener types could be substituted to provide other output voltages if required, but if this is done then some adjustment of the 390 ohm resistor may be necessary. The zeners may be individually selected if enough are available, to provide accurate output voltages.

The voltage doubler is conventional and again a wide range of diodes could have been used in place of the ones shown. A pilot light using a type 47 lamp is connected to the secondary of the transformer. A 4.7 ohm resistor is used to protect the lamp from the rise in secondary voltage on no-load, but this will be discussed later.

Overload Protection

The regulator system is capable of regulating the output against wide changes of input voltage from the main supply and it is this characteristic that is used in this unit to give overload protection. From the secondary of the transformer to the output, the regulator is of quite common design. Such a regulator will normally regulate up to the rated current limit of the series regulator transistor and other components, but will have little or no immunity against overload. Excessive load currents will generally cause overheating in the regulator with ultimate failure of one or several components. Many different techniques have been devised to protect this type of supply from overload. The most elaborate methods use some form of trigger circuit to electronically switch off the supply after a certain load current has been reached. This entails a reset procedure to restore the output after the cause of the overload has been removed. Another type of overload system ensures that the output voltage is abruptly reduced to a low and safe level after a certain load current has been reached. This type of protection is usually self-resetting in that once the cause of the overload has been removed, the supply will immediately return to its normal output voltage. It is one form of this type of protection that is used in this small power supply.

The simple addition of a capacitor in series with the transformer primary provides a convenient current overload protection with some other advantages. This capacitor is shown as Cp in **Fig. 1**. The effect is to cause the "vertical" voltage drop as shown on the characteristics in **Fig. 2**. It may seem at first to be a highly unlikely result so an outline of the action will soon be given. The high-current overload does double back as shown on **Fig. 2**.

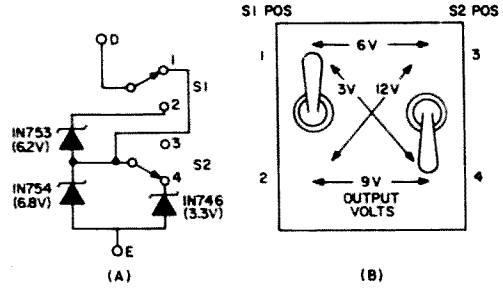


Fig. 4. The current-limiting switching arrangements. Two SPDT switches provide "off" and choice of three output current limits by selecting one of two capacitors, or both in series. The neon operates whenever the supply is "on," irrespective of which current limit range is in use. Switch positions are shown on both diagrams for ease of reference.

The switching arrangements for the current overload are shown in **Fig. 4**. Two SPDT toggle or slide switches (similar to the zener-switching ones) provide a "mains off" facility and the choice of three overload current limits. Two capacitors are used and these are connected individually and in series to provide a range of three capacitance values.

The Indicators

The neon pilot lamp is used to indicate that the supply is on. In one set of switch positions the neon is fed with 230 volts through the 0.5 μf capacitor. This capacitor has a reactance of 6400 ohms at 50 hz so has negligible effect when in series with the neon current-limiting resistance. This form of connection is necessary to ensure that the neon glows when the switches are in all three current-limiting positions, and yet is extinguished when the switches are in the "mains off" position.

It may seem strange that two pilot lights are necessary. The neon shows when the

power is on while the other lamp shows when an overload has occurred. The type 47 lamp extinguishes when an overload has been applied. While both lamps are lighted the supply is delivering its rated voltage. If the type 47 goes out then an overload has occurred. This arrangement works irrespective of the voltage output setting or the current overload range that is being used. With no voltmeters or ammeters used in the output (they were not considered necessary for the application in which this supply is used) this twin-lamp system has proved to be quite effective.

Overload Circuit Operation

The action of the series capacitor in the primary can be explained when it is realized that the input impedance of the primary of the transformer (when the dc output is on open-circuit) can be regarded in its simplest form as an inductance in series with a resistance. The inductance value is made up of transformer leakage reactance and some primary inductance while the resistance is made up of resistances representing the transformer losses and the load presented by the regulator components. The primary circuit is thus a series-tuned circuit, consisting of Cp, and the transformer inductance and resistance. This tuned circuit must not be at resonance at the mains frequency or excessive primary current would flow. The resonant frequency is made higher than the mains frequency and a change of Cp has the effect of changing this resonant frequency.

The primary current (with no load on the output terminals) is increased considerably with the inclusion of Cp. The current flowing is not in phase with the supply voltage so the power dissipated in the primary is small. The voltage across the transformer primary is increased to about 300 volts when the 0.5 μf capacitor is in circuit. This in turn means that the output of the voltage doubler is increased to about 20 volts dc when the supply is on "no load." The series transistor regulator accepts this 20 volt input and reduces it to 12, 9, 6 or 3 volts at the dc output terminals, even on no-load. When a load is connected to the regulator dc output terminals it has the effect of changing both the inductance and resistance values seen at the transformer primary. The resistance value increases as the load increases while the inductance value decreases. The resonant frequency of the primary tuned circuit therefore rises and the impedance presented to the mains input increases, causing a decrease in primary current. The Q of this series tuned circuit thus falls. The output of the voltage doubler and the 20 volt dc level at the input to the regulator drops. At some value of load current this dc voltage will have dropped to a point where the regulator can no longer operate satisfactorily and the output dc voltage now takes a downward plunge. The exact mechanism causing this steep fall is rather complex for the current and voltage waveforms at the transformer primary become distorted even though core saturation has not been reached.

At the overload point at the top of the downward plunge of the voltage curve, the type 47 pilot lamp goes out, showing that the transformer secondary voltage has dropped to a low level. With an overload current at the dc output terminals, the voltage at the output of the voltage doubler has dropped to about the same voltage as that at the dc output terminals, and with a short circuit, it drops to zero volts.

The overall result is most effective and especially is this so when component economy is considered.

The voltage rating of the capacitors must be high because under no-load conditions the voltage across the capacitor rises to about twice the mains voltage. The voltage rating should be 1 kv for 230 volt systems and 500 volts for 110 volt systems to be sure that the component will not fail.

Determining Component Values

This current-limiting technique has been applied to another power supply and it was found that a 4 μf series capacitor (1kv oil-filled) produced as steep a falloff as the 0.5 μf on the supply described. The value of capacitor to use for a particular value of current limiting is just about impossible to calculate for little is usually known about the transformer input impedance for the resulting dc load. The capacitor value is best determined experimentally by substituting

value after value (starting off with a 0.1 μf for 230 volt systems and a 0.25 μf for 110 volt systems) and plotting the output characteristics using an ammeter, voltmeter, and adjustable load resistor of suitable value. Increase the capacitor values in say, 0.25 μf steps until the desired cutoff current is reached.

One point must not be overlooked. If you try this with an existing supply (as I hope you will) make sure that the voltage ratings of any filter capacitors are not exceeded. Remember that the dc voltage output of the rectifier is increased by approximately 50% when the supply is on no-load. The primary voltage is increased by a like amount, but this is not as serious as it appears to be for the power factor is far from unity and little increase in transformer operating temperature (if any) will result. An ac voltmeter across the primary can be used to keep this under observation while substituting capacitor values. Remember that excessive primary currents can be drawn if the primary approaches resonance, so start off with the values of capacity quoted and increase it in small increments until the desired limit is reached, keeping an eye on filter capacitor voltage ratings. Remember too that you are playing with mains power so play it safe.

Other Advantages

Two other unexpected benefits also accrue from this series capacitor current-limiting arrangement. When first switching on, all the filter capacitors are discharged and the diodes would normally pass a very high current during charging. With this series capacitor in circuit, this charging current appears as an overload current and the initial charging current is limited. A resistor in series with the transformer secondary to limit the switch-on charging current as often used is now not necessary. The second added advantage concerns the size of the power transistor heat sink (if used). Because the dc input voltage to the regulator falls as the load current increases, the power dissipated in the series regulator is not as high as would normally be expected, and large dc output currents can be handled before a heat sink becomes necessary—this alone is an economy in space.

A change in mains frequency will have the effect of changing the current-limit level but this is unlikely to be bothersome if you draw your power from a large distribution system. A change of input mains voltage has a very small effect on the limit level and can be overlooked.

Ripple voltages, measured with a Tektronix 545B oscilloscope are shown in circles on Fig. 2 (millivolt peak-to-peak values), at various load levels. The lower output impedance and inferior ripple of the 3 volt and 9 volt curves can be attributed to the use of the 3 volt zener with its high dynamic impedance.

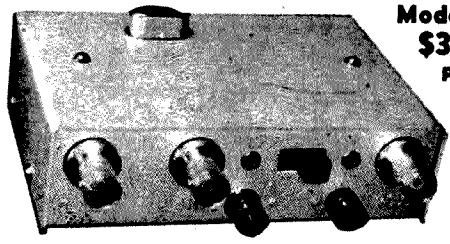
This supply has met my requirement quite satisfactorily and is giving good service.

Acknowledgment

I wish to thank Louis W5KFV for providing many of the components used in the development of this and many other projects.

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Slow Scan Color Transmission

Introduction

In 1861, James C. Maxwell demonstrated the principles of three-color photography. Maxwell analyzed a landscape scene through red, green and blue filters, and from the black and white negatives so produced, made three positive lantern slides. Then, by projecting the black and white lantern slides back through red, green, and blue filters, and superimposing the three pictures, he produced a color picture of the landscape. The principles of tricolor analysis and synthesis first demonstrated by Maxwell are still used today in the field of color photography, color printing, and color television. For example, the first close-up color photographs of the moon's surface were produced by a Surveyor satellite suitably equipped with a black and white television camera and color separation filters. More recently, the color photographs of the earth taken by an Application Technology Satellite (*Scientific American,* 1969) are but another example of color photography by means of color analysis and synthesis.

The application of color analysis and synthesis techniques to amateur television follows as a logical step in the development of this communication mode. In particular, the technique is here applied to the field of slow-scan television, giving the amateur a capability for the long-distance transmission of color information.

Color Principles

In 1801, Thomas Young put forth a hypothesis that human color vision is based on a three-part color analysis, in the eye, of the light received from an object. Young's investigations were extended by Helmholz and others, who showed through mixing experiments that almost all colors could be matched by a mixture of three colors. The three colors used in the matching process are not specified; but then, there are no three unique components that must be used for color matching. It can be shown, however, that red, green, and blue components permit matching the greatest spectral range of colors (without using negative quantities of a component), and for this reason, red, green, and blue are considered as the *primary colors.*

James C. Maxwell, in 1861, demonstrated that the above principles could be used to reproduce a colored scene, and thus laid the foundation for current three-color photography, printing, and television. Maxwell exposed three separate photographic plates to a landscape scene through red, green, and

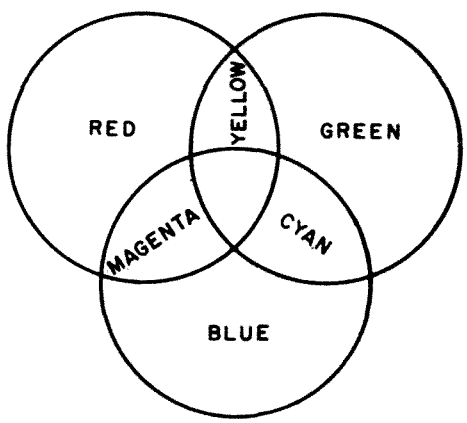


Fig. 1. Color mixture by addition.

blue glass (filters). The photographic emulsion exposed behind the red filter, when developed, showed, in terms of silver densities, the amount of red light reflected from the scene. Areas of the landscape which reflected greater amounts of red light yielded greater densities on the corresponding parts of the black and white negative. Where a lesser amount of red light was reflected, a lesser density was obtained. Similar statements apply to the negatives made with the green and blue filters (substitute "green" and "blue" for the word "red" in the above sentences). Colors formed from two or more colors were recorded on two or more negatives in proportion to the amount of each primary color reflected. Thus, the set of three black and white *separation negatives* recorded the *tricolor analysis* of the scene.

To reproduce the landscape analyzed by tricolor analysis, Maxwell first produced a positive transparency from each of the three separation negatives. These positives were then placed in magic lanterns, and a colored filter corresponding to a given positive's separation filter was placed in front of each lantern. That is, a red filter was placed in front of the lantern containing the positive made from the "red" negative, etc. With the intensities of the lanterns properly adjusted, a reproduction, or synthesis, of the landscape appeared on the screen. Although the reproduction was poor by today's standards, the basic principles of three-color photography had been established.

Maxwell reproduced his image by *additive color synthesis,* wherein three colored light images are added together to obtain a suitable mixture. This process is illustrated in Fig. 1, where white-light sources are projected onto a screen through three primary color filters. Besides the areas where the primary colors are observed, and where all three colors are superimposed (white), three additional colors are observed. These are: cyan, (white light minus red); magenta (white light minus green); and yellow (white light minus blue). This suggests that color mixing may be performed using the colors of cyan, magenta, and yellow; that is, by subtractive mixing.

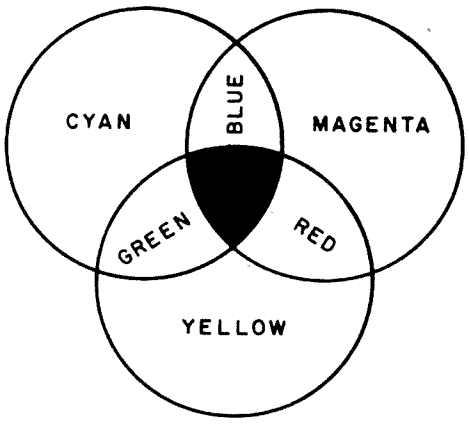


Fig. 2. Color mixture by subtraction.

Fig. 2 shows a subtractive mixture of colors produced by projecting a single white light source through an overlapping set of staggered subtractive filters (i. e., cyan, magenta, and yellow filters). Besides the three subtractive colors observed on the screen, we can see areas of red, green, and blue. Where all three subtractive filters overlap, no light (black) is projected. Thus in Maxwell's experiment, let us dye the positive silver image prepared from the red filter separation negative cyan. Similarly let us dye the positives prepared from the green and blue filter-separation negatives magenta and yellow, respectively. If we now place all three dyed transparencies in the same projector, we obtain a color picture (without having to use any filters in front of the white light projector) by *subtractive color synthesis.* Our present color photography and color printing methods employ the principles of subtractive color synthesis, and it is this technique we used to synthesize the first color picture transmitted by slow-scan television.

Method

The general method employed to analyze and synthesize the slow-scan color television picture is shown diagrammatically in Fig. 3. The subject here, a black circle containing red (R), green (G), and blue (B) circles, is first illuminated with white light. The subject is then viewed (in sequence) through red, green, and blue filters by an SSTV flying-spot scanner or vidicon camera, and the three black and white pictures obtained – which might be called the separation pictures – are recorded on a conventional audio tape recorder. Once taped, the pictures may be transmitted over the air or

on the telephone lines; the tape can also be forwarded through the mail. Whatever the means of transmission, the pictures are eventually played back at the receiving end, whereupon three black and white photographs, corresponding to the three separation pictures, are taken of the monitor's display. Note that no filters are required at the receiving station; the three black and white pictures transmitted already contain the necessary tricolor separation information.

Once the monitor's output has been photographed using a conventional camera (time exposures are taken of the three separation pictues), the film is developed. This yields a set of separation negatives from which are prepared three positive prints. Halftone negatives are now made from the three positives, and these negatives processed using the Color-Key printing technique. If the three processed Color-Key films are now superimposed on a white background, the resulting color image is a reproduction of the originally televised color subject.

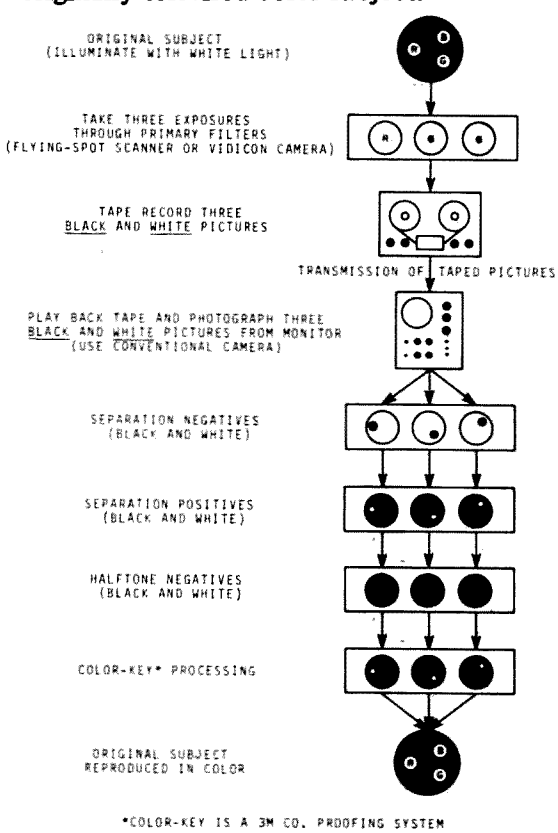
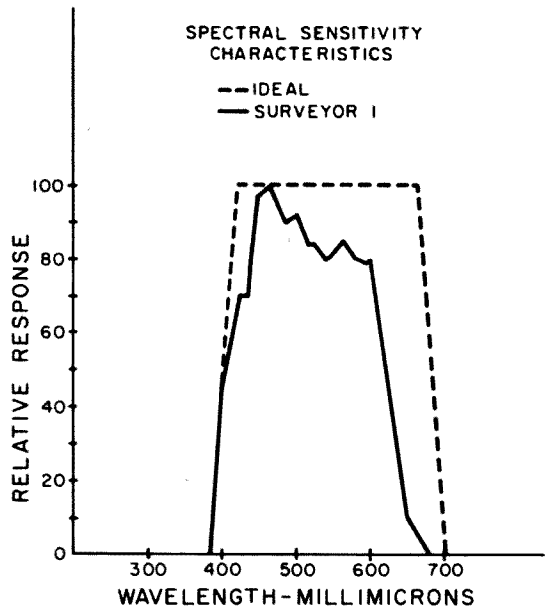


Fig. 3. Color reproduction by means of color analysis and synthesis. This was the method used by W4UMF and Mr. Tarr to reproduce the first color picture transmitted by amateur SSTV.



MODIFIED AFTER: SURVEYOR I: PRELIMINARY RESULTS, SURVEYOR SCIENTIFIC AND EVALUATION AND ANALYSIS TEAM, SCIENCE, VOL 152, 24 JUNE 1966

Fig. 4. The ideal total-system response for color analysis work. This response is shaped, using single-color filters, to produce a response which matches the standard color-matching functions. The total-system response for the camera aboard Surveyor 1 is shown for comparison.

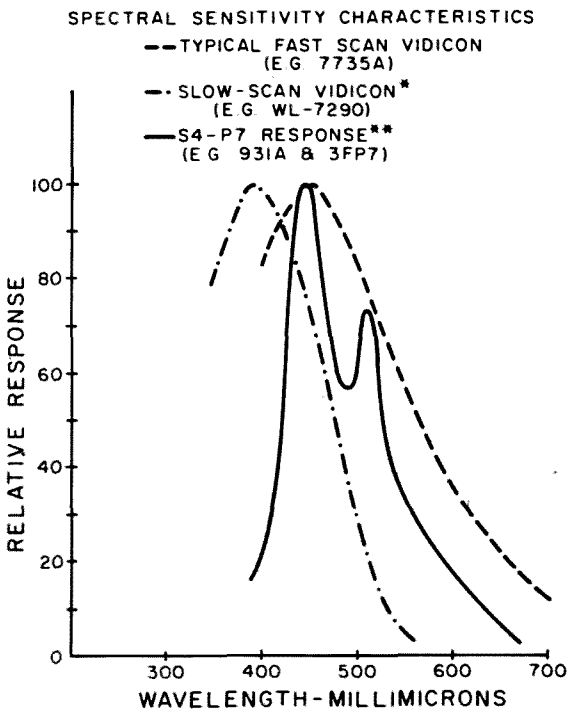
Having outlined the basic principles of color analysis and synthesis, and the application of these principles to the transmission of color pictues by slow-scan television, let us now turn in detail to the techniques employed.

Color Analysis

Ideally, one would wish that the response of his television system be similar to that shown by the dashed line in Fig. 4. The response is seen to be flat over the entire visible spectrum, and thus, it should be possible to select single-color filters which, when placed in front of the imaging system, produce an overall camera-filter response which can match the standard color-matching functions (Commission Internationale de l'Eclairage, 1931). That total system response functions close to the ideal can be achieved is evidenced by the spectral response curve of the Surveyor 1 television cameras (clear position on the filter wheel, solid line, Fig. 4). Overall camera-filter spectral response functions for Surveyor 1 can be found in the report of the Surveyor

Scientific Evaluation and Analysis Team (1966), and for Surveyor 3 in Shoemaker, et al. (1968).

As television cameras with "ideal" spectral response curves (like those of the Surveyor cameras) are necessarily expensive, we should not be surprised that the imaging systems employed by amateurs use tubes with response curves far from the ideal. Fig. 5 shows the response curves for three classes of imaging systems used in amateur slow-scan television work. Flying-spot scanners (e. g., see Hutton, 1967) typically use 931A photomultiplier tubes (S4 response) together with a P4 or P7 CRT raster source. Slow-scan vidicon cameras, on the other hand, generally employ image tubes like the Westinghouse WL-7290. Only recently, Taggart (1968) and Hutton (1969) have demonstrated the use of conventional fast-scan vidicons (e. g., 6326, 7038, 7735A, etc.) in the slow-scan mode. Thus, we essentially have three classes of image-tube response to choose between. Of these, the conventional vidicon's response is superior, followed by the spectral response of the S4-P7 flying-spot scanning system. The slow-scan vidicon, however, peaks in the violet, and experiments at W4UMF have shown that its extremely low output in the red (visible wavelengths greater than 610 millimicrons) eliminates it as a possible image pick-up device for direct color separation work.



*REF.: SLOW-SCAN VIDICONS; LIGHT INTEGRATION & STORAGE, NARROW-BAND VIDEO TRANSMISSION, WESTINGHOUSE, APRIL, 1968.

**REF.: AVERAGE RESPONSE; S4 SENSITIVITY (2870° K TUNGSTEN SOURCE) TIMES AVERAGE P7 SPECTRAL-EMISSION CHARACTERISTIC, RCA HB-3 TUBE MANUAL.

Fig. 5. Three classes of image-tube response used in amateur SSTV systems. The response of a conventional vidicon is preferred for color analysis work, followed by the response for an S4-P7 flying-spot scanning system.

Robert Tschannen's (W9LU0) dual-931A flying-spot scanner was used for the color analysis phase. This scanner, similar to that described by Hutton (1967), employs a 15 hz horizontal frequency and an 8-second frame period (120 lines). The total-system spectrum response function was shaped for color separation by inserting red (Wratten No. 25) and blue (Wratten No. 47) filters in front of the photomultiplier tubes. No filters were used in producing the green separation picture. While the green separation picture therefore contained, in reality, blue-green information, this color bias was compensated for in the production of the Color-Key print.

The subject chosen for the initial color separation tests is shown on the cover, bottom left. Anyone who has ever tuned a color TV set or viewed a color slide can attest to the fact that the faithful reproduction of skin tones is essential to good color imaging. Thus, it was felt that a subject such as that chosen would provide a good test of the techniques to be employed.

To correct for the non-uniform spectral response of the system, the following procedure was used in preparing each of the separation pictures. With a given set of color filters in place (or no filters, in the case of the green picture), a white card was substituted for the subject picture, and the phototube outputs set to a predetermined level. This level, which was the same for all three white-card separation pictures, was sufficiently high to produce a white picture on the slow-scan monitor. Following equalization of phototube outputs, the subject picture was placed in the scanner, and 8 separation-picture frames were recorded on

magnetic tape. Every effort was made to replace the subject picture in the same position following each equalization adjustment; an attempt was also made to maintain a common size for the scanning raster. The necessity of alternately changing picture and card for primary output adjustment could account for some of the misregistration seen in the synthesized picture. It is to be noted that slight defocusing did occur on the red separation picture. This is a result of having to drive the raster source CRT quite hard before obtaining the desired output equivalence.

The recorded pictures were mailed to W4UMF for color processing. The question of whether these pictures should have been transmitted by SSB on 20 meters, via the phone lines, or by tape through the mail is purely academic; tests conducted during the past two years have proven all three transmission modes capable of yielding high-quality SSTV pictures.

Color Synthesis

To produce the required separation negatives, the taped separation pictures were played back through a 3" monitor, and photographed on black and white 35mm film. The camera used was a Bell and Howell-Canon single-lens reflex with a 35mm f/1.8 lens. A close-up lens was also attached. The camera was tripod mounted, and a remote shutter trigger employed to minimize changes in the camera's position. While small lateral and vertical changes in the camera's position can be corrected for in printing the Color-Key picture, changes in the distance between the camera and monitor will produce variations in picture magnification. Such variations in image size are difficult to compensate for, and can result in significant color fringing.

Use of 35mm film necessarily required that the separation negatives be enlarged prior to printing. This suggested that fine-grain film be employed. The film chosen was Kodak Panatomic-X.

The Panatomic-X film has an ASA rating of 32. Because of this rating, and the low light level of the CRT flying spot, it was necessary to experiment with aperture settings. Aperture settings of 1.8, 2.8, 4 and 5.6 were used in obtaining the 3-picture sets.* All pictures taken were 8-second (one frame) time exposures. The black background of the original subject was used as a guide for proper adjustment of the monitor. That is, the brightness for each picture was set such that the CRT beam was just extinguished in the black portion of each frame.

The exposed film was processed in accordance with the film manufacturer's specifications. This not only assured us of obtaining proper silver densities in the negatives, but should also permit duplication of the results obtained to within narrow limits.

The 35mm separation negatives photographed from the monitor were quite contrasty. This was due in large part to the lack of tonal gradation in the pictures displayed on the monitor. As the P7 cathode-ray tube is capable of reproducing only 4 or 5 shades of gray, some tonal adjustments had to be made in the synthesis process. These adjustments will be discussed in detail later in this section.

From the 3-picture sets available, separation negatives were chosen for Color-Key processing. The choice of negatives was not too critical, as one can exert some control over picture characteristics (i. e. density, contrast, etc.) in a separable subtractive color process such as the dye transfer or Color-Key process. The white flaring was introduced in the analysis process (glare).

The Color-Key method for color printing was used to synthesize the tricolor-analyzed picture. For a complete survey of Color-Key printing the interested reader is referred to the literature on color printing processes.

Color-Key is primarily used by lithographers to produce proofs of separated negatives for multicolor printing. The process can be used by anyone with access to a high intensity lamp. In addition, materials are available in most areas of the country, which is not true of other processing mate-

*The monitor at W4UMF employs a 3RP7A CRT, with an accelerating voltage of 1600 volts. Most monitors use 3FP7A, or 5ABP7 CRT's, which generally employ accelerating voltages closer to 3100 volts. If tubes of the latter type are employed, and Panatomic-X film is used, it is suggested that stops between 2.8 and 8 be tried. If a film such as Plus-X is used with a high accelerating voltage CRT (~3100 volts), f/stops between 8 and 11 should produce good 8-second time exposures.

rials investigated (e. g., dye tranfer materials). Color-Key is easily handled in subdued light and has a one-step developer which is applied with a cotton swab.

Because of its lack of tonal range, Color-Key must be exposed using a halftone or screened negative.

The Color-Key process uses three sheets of film, each dyed one of three colors: cyan, magenta, and yellow. The halftone negative for the complement of each Color-Key dye is exposed and developed separately. The resulting Color-Key positives are then aligned, one on top of the other. Viewing through the composite film *should* produce a color reproduction of the original color scene. We use the word "should" because of the problems encountered.

It was mentioned earlier that the negatives photographed from the monitor were of high contrast. As such, the glossy photographs were also without tone gradation, and thus, the halftone negatives had relatively little tone variation. The reason for this follows. Let us examine the synthesis process in detail. Consider that black and white picture on the monitor which had been analyzed through the red filter. The picture had white areas on the screen where the skin tone was on the original. As the skin tone (large percentage of yellow-red) would pass through a red filter, the face should have appeared light gray. The green area of the dress, composed of cyan and yellow, was not entirely passed by the red filter, and should have appeared dark gray on the screen. This area however, was displayed as black. This shift to higher contrast is a product of the monitor's CRT limited dynamic range. Thus, it was not possible to accurately reproduce the tones of the original picture. Similar statements apply to the green and blue separation pictures as observed on the monitor. As such, we were required to use some color correction to reproduce the tone values between white and black.

After all the Color-Key positives were made, it was determined that more magenta and yellow was needed to reproduce a realistic skin tone. Adding these colors would also make needed corrections in other areas of the picture to correct for the blue-green bias in the original SSTV separation piotures. Color-Key sheets containing dot patterns of 50% color value at 85 lines per inch were added. This corrected the color to within reasonable limits over the entire picture. No attempt was made to correct particular areas of the print; all areas were treated uniformly.

Results

The processed color print is shown on the cover, at the right. In judging the quality of the reproduction, we should be aware of the inherent resolution limitation (120 lines) of the slow-scan system, and the limited dynamic range of the monitor's CRT. To the extent that the Color-Key print approximates the color of the subject, however, we class the quality of the synthesized color print "fair."

Comments and Conclusions

In the case of the picture processed above, the original color photograph was available to be used as a guide in the synthesizing process. To eliminate the need for viewing the original color photograph during color synthesis, it is suggested that a small color-bar set be included in pictures to be analyzed. Upon synthesis, accurate reproduction of the color bars will insure proper color balance in the subject.

We have demonstrated the feasibility of transmitting color pictures by slow-scan television, using the method of color analysis and synthesis. In particular, picture reconstruction was performed using a separable subtractive color process – the Color-Key process. Though the color analysis phase of the test and the production of the separation negatives may seem heuristic in character to the critical experimentalist, the procedures described nevertheless do work. We would hope that more experimentation will be done using the Color-Key process as this process can produce excellent results given separation negatives of good tonal gradation.

That prints made using the Color-Key process are considerably more expensive than conventional color prints, and that an experienced amateur photographer is more apt to obtain the desired results when using this process, would seem to limit the application and use of the color transmission method described. However, given today's

technology in quick-processing films (e. g., Polaroid Polacolor), and a continued experimental effort on the part of the amateur-photographer, it is expected that technically and economically more appealing synthesis techniques will be developed shortly for the color transmission by slow-scan television.

. . . W4UMF & Tarr

Acknowledgement

The assistance of Mr. Robert Tschannen, W9LUO, in preparing the separation SSTV pictures, is gratefully acknowledged. The authors further thank Mr. Tschannen for many stimulating discussions on color separation, and for his critical reading of the manuscript. The authors also thank Mr. Charles Cowden, K6BL/4, and Capt. David Veazey, W4ABY, for providing 20 meter liaison communications between W9LUO and the authors.

Mention of trade or brand names is solely for identification and does not imply endorsement of products mentioned, nor does it imply nonendorsement of unnamed products.

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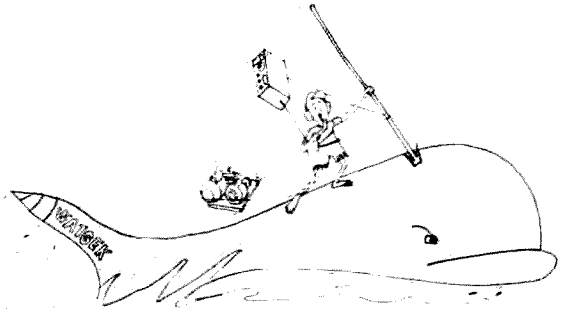
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Fascinating Fundamentals

Volta and His Pile

Although this article is about Volta and the invention of the electric cell, it would be incomplete without at least a mention of another Italian, Luigi Galvani. Both these men stumbled over the same principle, and both men misinterpreted it, although Volta's interpretation was most nearly accurate. Galvani's main field of operation was electric detectors. After his wife was scared out of her wits by a pair of frog's legs that jumped without having the rest of the frog attached, and after she suggested to her husband that the phenomenon just might have something to do with his electric machines, Galvani "discovered" this very sensitive method of electric detection.

Galvani worked for a number of years with his frog legs, and during the course of his experimenting, he completed a circuit to a pair of legs by way of a copper wire and an iron fence. He observed that the legs would jump when connected through two different metals, but not when only one kind of metal was involved. Not being concerned with electric generation, he continued his experiments in the field of detection.

This was in the latter part of the eighteenth century, and in those days, the only source of electric power was from electrostatic machines. Just a few decades before, Franklin had discovered atmospheric electricity through his famous kite, but this had proven to be a difficult source to control. Nobody had, as yet, said so, but the thing most needed to further the progress of electricity was a source of continuous current.

Galvani had been convinced that his connection of the frog legs to the metal strips had shown evidence of what he called "Animal Electricity." Volta thought differently. He felt sure that the source was not in the animal tissues, but rather in the connection between the two metals. He came awfully close. For quite a while he experimented with a great many combinations of metals, and eventually came up with a list so arranged that any metal shown would generate a positive charge when contacted with any metal below it. His one misconception, and it was a minor one, was that it was the CONTACT between the two pieces that produced the charge.

Volta had tried to improve the connection between the metals by moistening them with brine. In time he found that the same result could be had if the two pieces were altogether separated. He still believed, however, that it was only the connection between the metals, and not a reaction with the brine that produced electricity. Soon he was making stacks of his cells piled one on top of the other. This, naturally, produced a more powerful charge and, while its power was nowhere near that of the static machines, it never had to be recharged. Here,

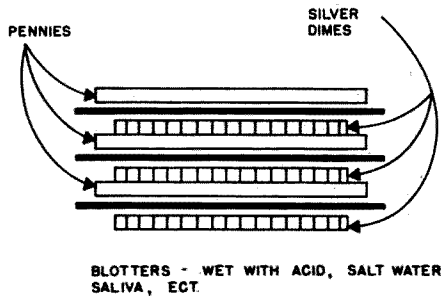


Fig. 1. Volta's pile (also called the spit-on-a-dime battery). Blotters should be moistened. This always used to be made with the older silver dimes. I don't know how well it will work with the new ones.

then, was a source of continuous current. Volta published his conclusions in a letter which was read to the Royal Society in England on June 26, 1800. On that day, electricity took a giant step forward. In the next half century, many improved cells were developed by such men as Faraday and Davy, but it was Volta who started it.

Volta's one misconception, that electricity was being generated by the action of the two metals with each other, was not too far off. Actually, it is the action of the two metals AND A CHEMICAL. In the table, we see the potentials which can be produced with a few common metals and various solutions. To determine the potential you will get, take the DIFFERENCE between the potentials of the two metals you will use. For instance, with a sulfuric acid solution, zinc has a potential of 0.0, and copper, 1.007. If you immerse a strip of copper and a strip of zinc in a jar of sulfuric acid, there will be a potential of 1.007 volts between them. Lead, however, has a potential of 0.513. A cell made of copper and lead will produce only 1.007-0.513, or 0.494 volt. Try it yourself. All you need is a peanut butter jar (empty), some metal, and some acid. You can get the acid at any gas station. Just ask for some battery acid.

Solution	Sulphuric Acid	Lye	Salt
Metal			
Zinc	0.0	-0.321	?
Lead	0.513	0.318	0.512
Tin	0.513	0.002	0.503
Copper	1.007	0.802	0.809
Silver	1.213	0.958	1.013

Table 1. When immersed in any of the solutions shown, any two of these metals will produce a voltage equal to the difference of their potentials. For instance, Zinc and Silver in a solution of lye: E = 0.958 (-0.321), or 1.179 volts.

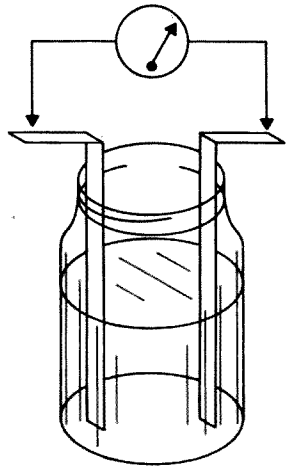


Fig. 2. A simple jar cell. See table for solution and metals.

I once made a demonstration cell by filling a tin can with a solution of vinegar and immersing a copper pipe. Between the copper and the tin, there was about half a volt, and if I had used sulfuric acid instead of the vinegar, that would agree quite well with the table.

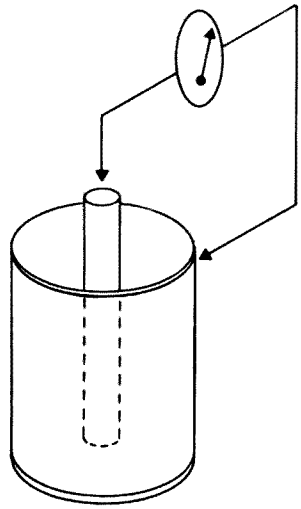


Fig. 3. The "can-full-of-vinegar" cell.

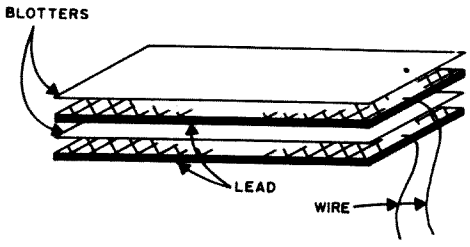
A storage battery is one in which the chemicals can be renewed by sending a current through it in the reverse direction. Take two strips of lead, and score criss-cross lines on them with a scriber. Then roll them together between two pieces of blotter,

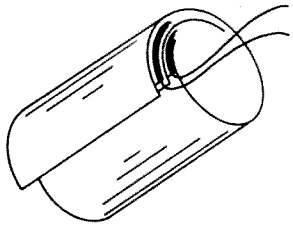
making sure that they do not touch each other. Put the whole thing into a jar and add some battery acid. Now "charge" it by connecting it to a two or three volt dc source. After an hour or so, remove the source and you will find you have made a 2 volt storage cell.

. . . W2FEZ ■

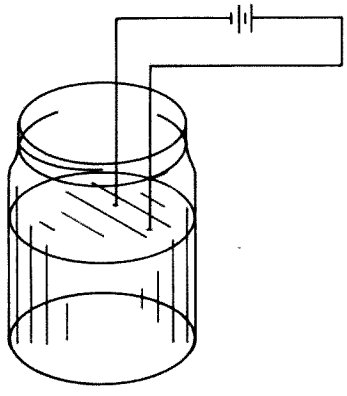


Score the lead like this.





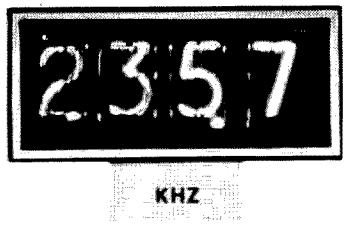
Roll them up.



Put them in a jar and charge them.

Fig. 4. A simple storage cell. Make sure the lead pieces do not touch each other. Fill the jar with battery acid obtained from a local gas station. Once it has been charged the first time, mark the polarity and always observe it in future chargings.

Feature This



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November 12, 1969

73 Magazine
Wayne Green

Dear Wayne,

Since I have enjoyed reading the material you have written over the years, I have made up a little antenna story for you. I hope you enjoy reading it.

If by chance it has publication value, there is an automatic discount for rewriting of 27%.

The commercial price is therefore your choice of 73¢, $7.30, $73.00, or $730.00. I positively will not accept more.

James M. Fisher, W3KNG

1.

The 20 Meter DX Copper Ball Antenna

On a recent trip through a large hardware store, it was discovered that there is a plastic toilet float on the market. This may mean the eventual demise of the classic copper toilet float. In case this could happen, it was thought advisable to describe the old "toilet ball" 20m DX antenna before parts for this famous old antenna are no longer available.

The origins of this trusty old skywire, if documented, are not available to this author. Like legends, the design has filtered down through word of mouth. However, a tip of the hat to the inventor, wherever he may be. It's a good one.

It was developed when 20m first became a ham band, long before the beams of today were in use. Basically, it is a very simple antenna to build and use, and will perform as well as any dipole. The components themselves are inexpensive, and no elaborate towers or rotators are required. It has no apparent directive pattern. Using this antenna on 20m CW, and the modest power developed by modern transceivers, barefoot, it is easy to work around the world.

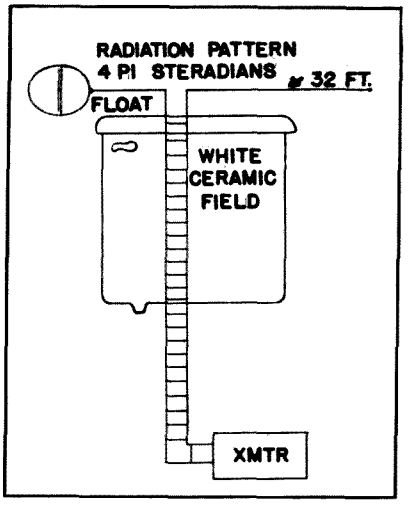
The theory behind the design is very simple: Half the transmitted energy is concentrated on the outside of a copper toilet float, and half is loaded into a 32 ft. wire counterpoise. The ball develops a fierce concentration of an electrostatic field, and really shoots this energy out, covering the entire world (which, incidentally, is also globe-shaped).

The counterpoise, loaded primarily with the electromagnetic component of the transmitter's output, nicely provides background fill for the ball's radiation, giving depth and smoothness to the signal. The ladder line feed not only separates the electrostatic and electromagnetic fields to their ball and counterpoise, but actually convert the low impedance energy in the coaxial cable to the hot juice needed to make the ball sizzle.

Construction is not difficult. The insulators around the ball mount should be ceramic, and if you are going to use a kW, they should be a minimum of 4 in. long. The counterpoise should run in fairly clear space, several feet from trees or buildings, if possible. The ladder line should be mounted by regular TV standoffs, except for the top three feet, which should be either in the clear or on good white ceramic. The entire ladder should be guarded from contact by children or pets.

The whole shebang, ball and counterpoise, should be about 16 ft above ground. Build it and have a BALL!

. . .James M. Fisher W3KNG



phone 603-924-3873

73 MAGAZINE
PETERBOROUGH, NEW HAMPSHIRE 03458

Dear Jim,

Thanks for letting us have the first opportunity to publish the article on the copper ball antenna. Some of the 73 staff became so inspired by your write-up that they built up a couple of the devices for the station here.

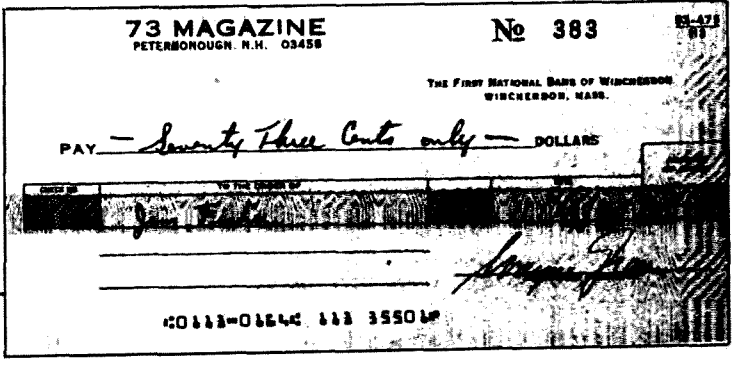
Needless to tell you, we've had phenomenal success with DX, even to the extent of working contacts in areas thus far uncharted.

Some inconvenience has occurred as a result, however. The nearest service station is several miles away, and its restrooms are damp and cold. Hardly a substitute for the nice ones we had on the premises before your article came in.

At any rate, we accept your article, and tender our check to you herewith.

73,

Wayne Green



John J. Schultz W2EEY
1829 Cornelia Street
Brooklyn NY 11227

Base - Tuned Center - Loaded Antenna

No, the title is not incorrect. An antenna can be center-loaded without having the reactive element physically present at the center of the antenna. Transmission line transfer of the reactive element is the key.

There is certainly nothing new about base inductive loading of a vertical antenna. The method is convenient and often allows easy construction of an antenna. The disadvantage, of course, is low efficiency when the antenna is shorter than ¼λ long at the operating frequency. As shown in **Fig. 1**, the high current flow at the base of the antenna means that the greatest current flow takes place through the coil's relatively small conductor. Various solutions have been tried to get around the problem of distributing the current flow in an antenna such that the reactive elements necessary to bring the antenna system into resonance do not also produce the greatest losses. The helical antenna was one solution. By distributing the inductive loading along essentially the entire length of the antenna, the average current flowing through the base section of the antenna was reduced. Center lumped inductive loading (**Fig. 1**) has become the most popular method, however, since it allows the heavy base current to flow through the bottom section of the antenna, which is not loaded, and because of its constructional advantages, particularly for mobile antennas.

The method is not always practical for fixed station situations, however, where the antenna center may not be accessible to change coils for various bands. Usually, the fixed station operator who is constrained to using a vertical antenna on several bands has had to settle for base loading and could simply take the approach of making the base loading inductor as hefty as possible in an effort to reduce its losses. This article explores a method by which the efficiency of such an antenna can often be considerably improved by a form of pseudo-center loading using a transmission line to transfer the reactance of a loading element located physically at the base of the antenna electrically to its center.

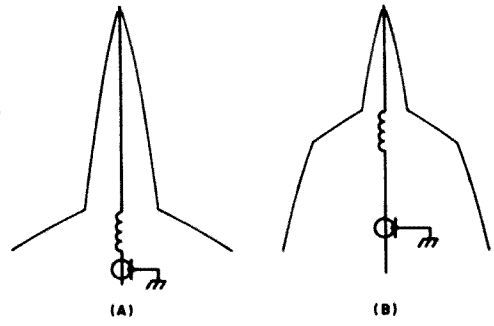


Fig. 1. Improved current distribution of center-loaded antenna (B) over base-loaded antenna (A) allows highest currents to flow where ohmic losses are low.

A note should first be made concerning the function of the loading inductor in a center loaded antenna. The inductive reactance is necessary to make the electrical length of the antenna equal a ¼λ so that the base impedance will match a coaxial transmission line and the antenna will accept a transfer of power from the transmission line. Unless the loading inductor is extremely long or wide, it does not radiate any

appreciable signal. The radiating is done by the rest of the antenna. If the copper losses in the inductor are not kept low, the inductor will act in a manner similar to a dummy load and simply produce heat. The inductors used for the center loading of short mobile antennas are usually not shielded because weather protection can be obtained by epoxy coatings and a shield must reduce the inductor's Q or efficiency. The coil, however, could be shielded with a large enough enclosure so that the effect upon the Q would be small and antenna performance would not be affected thereby.

So, if the antenna saw the proper value of loading inductance at its center, regardless of where the physical inductor was placed, it would operate the same as it did with the physical loading inductor at its center.

Reactance Transfer

One method that can be used to transfer a remotely located reactance to the center of an antenna is via a transmission line. Transmission lines can actually be used not only to transfer reactances but also to simulate them. The latter feature is commonly used when stub matching is employed to simulate the necessary inductive or capacitive reactance to correct a mismatched transmission line condition. By a combination of using a lumped reactance at the end of the stub and the effect of the stub itself, almost any value of inductive or capacitive reactance can be created. The reactance so produced can have quite high Q and a low power factor depending upon the quality of the lumped reactance and the losses of the transmission line. By using the proper length and/or termination for a transmission line, it can also reflect an open or short circuit and be used as a remote switch.

Fig. 2 shows how a length of transmission line also can act as either a capacitive or inductive reactance. The chart shows how a short circuited stub can increasingly act as an inductor until it is ¼λ long and then start simulating a capacitive reactance beyond ¼λ. If the stub were open-circuited, the

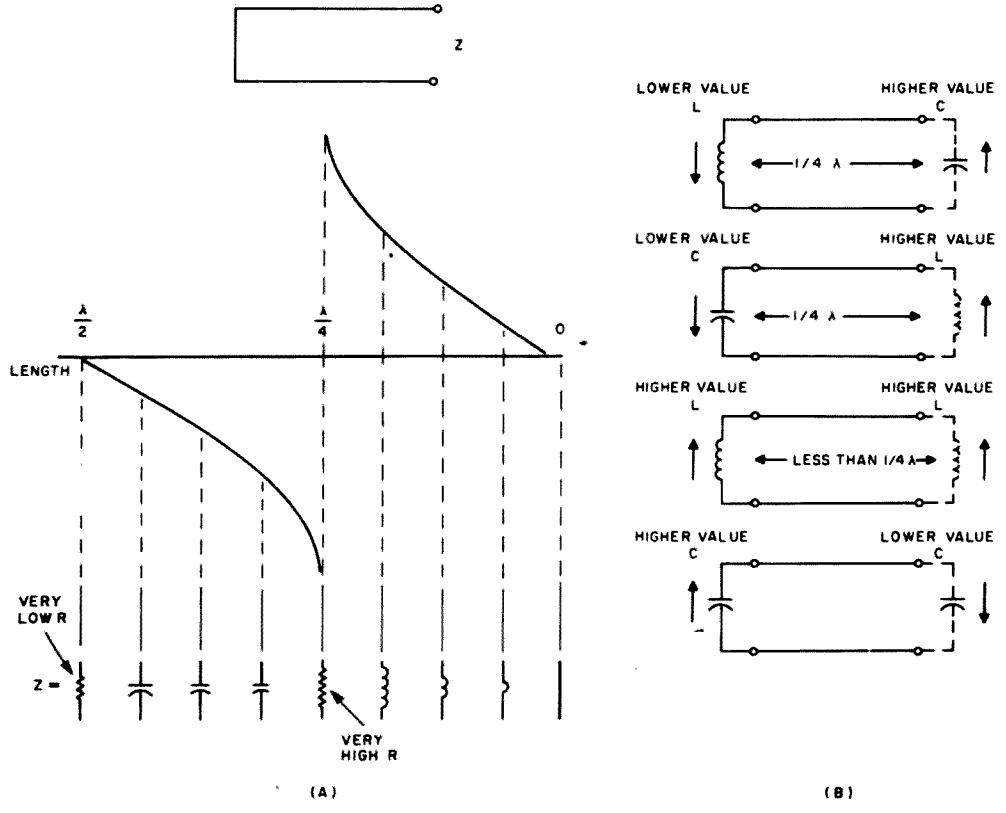


Fig. 2. (A) illustrates how length of transmission line can simulate a series of reactances depending upon its length. (B) shows some of the transfer reactances possible when a lumped reactance is used on the end of a stub. A line exactly ½λ long will transfer exactly the same value as the lumped reactance.

opposite reactive condition would apply. That is, capacitive reactance would be produced until the stub were ¼λ long and then at exactly ¼λ length it would act as a short circuit.

For those who don't mind a bit of math, the reactance produced by the stub when up to a ¼λ long is:

X_L (short circuited stub) = Z tan (2π L/λ)

X_C (open circuited stub) = Z/ tan (2π L/λ)

Z is the impedance of the transmission line used to make up the stub and L/λ is the line length in wavelengths. The physical line length is affected by the velocity factor (usually .66 for coaxial lines) and shorter by that factor than a free-space wavelength.

Although the reactance values repeat as the stub is made odd multiples of a ¼λ long, such long lengths should be avoided if possible. The highest Q will be obtained when the stub length is less than ¼λ. Once one knows the reactance produced by the stub, one can calculate or look up a reactance graph to determine how many microhenrys or picofarads are produced at any particular frequency.

Also, to obtain the best Q, a cable of the lowest loss possible should be used and also one with an inner conductor radius to inner radius of outer conductor ratio of 3 to 5. Not all cables can satisfy the latter criterion, RG/59 cannot, for example. RG/58 and RG/14 both are usable and the latter cable is particularly useful, although it is a bit large (.55" diameter) to satisfy the requirement for low loss and the proper geometry for high Q as a stub.

Short or open-ended stubs alone are limited in ability to produce simulated values of capacitance or reactance simply because of the fixed impedance of the cable used. Replacing the short or open-ended termination with a lumped reactance will, however, extend the range to any desired value. The terminal reactance produced by a stub with a lumped reactance at one end can be calculated or found by a Smith chart plot for various stub lengths. Reference should be made to an antenna or transmission line manual for the method. However, as a general indication of what effect lumped constant termination will have in order to experimentally determine the required reactance, **Fig. 2** can be used as a guide.

Practical Application

Fig. 3 shows how the principle outlined for transfer of the center-loading reactance can be applied. By using the proper value of loading reactance, the overall antenna is resonated either as a ¼ or ¾λ vertical, and so its feed point impedance will match a 50-ohm transmission line directly. The coaxial line used to transfer the base reactance is placed inside the lower element of the antenna. The reactive components themselves can be placed in a shielded enclosure, if desired, but note that both sides of the coaxial transfer line must remain insulated from ground. There will be some radiation from the coaxial transfer line although the portion enclosed in the lower antenna section will not cause any problem. The exposed portion can cause various problems, including pattern distortion of the vertical if it is made too long. Basically, the method of reactance transfer was meant to function with the physical reactance at the base of the antenna and not 100 feet away. Therefore, the dimensioning of the antenna sections and the length of the coaxial transfer line must all match to achieve proper operation of the antenna on various bands and positioning of the base reactive elements.

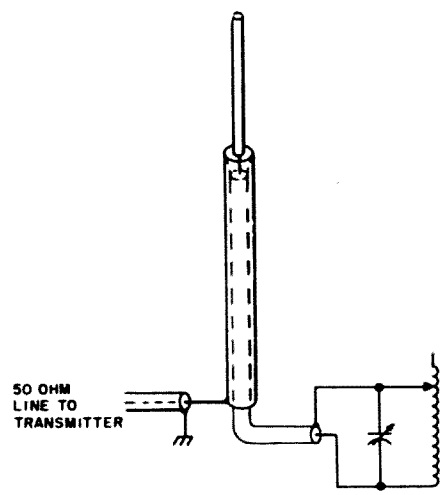


Fig. 3. Coaxial line placed inside lower antenna element to effect reactance transfer from base to junction of upper and lower antenna elements.

With some care, many combinations can be found that will work. One combination that was experimented with used a standard 10 foot TV mast as the antenna lower element and a smaller diameter 5 foot tube, insulated

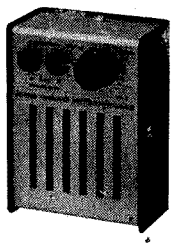
from the lower element, as the top element. inside the ten foot section. Since ½λ of this cable on 10 meters was 10.8 feet, it provided a very convenient length to the base of the antenna. Either a B & W stock 3905-1 coil (6 TPI, 2½" diameter) or a 500 pf variable capacitor was used to resonate the antenna, depending upon the band and the antenna's mode of operation.

On 10 meters, some slight inductance was used at the base to make the antenna operate in a ¾λ mode in order to match the transmission line to the transmitter. On 15 meters, capacitive reactance was used to make the antenna operate in a ¼λ mode. On 20 meters some very slight capacitive reactance was also required. On 40 and 80 meters, the transfer line length is quite short in terms of wavelength and additional inductive reactance at the base was used.

Tuning of such an antenna can initially be done using an SWR meter in the transmission line to the transmitter. One should try both the inductive and capacitive element at the base on each band, varying their value until the SWR is brought down as close to 1:1 as possible. Generally, the minimum amount of reactance that will achieve resonance should be used since additional reactance means additional losses. Some confusion will occur on the higher frequency bands because the length of the transfer line and antenna may allow various combinations of base reactances to resonate the system. The only solution in such a case is to use a field strength meter or, preferably, check signals with a distant station to determine which reactance value produces the best radiated signal. Once the proper reactance values are found, they can be bandswitched, if desired, although the tuning does become critical on some bands; a better solution might be to switch the inductor and capacitor (with various taps on the former) and use a simple tuning chart on each band to locate the correct settings.

With a vertical antenna, the transfer of the loading to the base does not affect the fact that either a radial system or good ground connection must be provided if the antenna is always operated in a ¼ or ¾λ mode for direct match to a 50 ohm transmission line.

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Summary

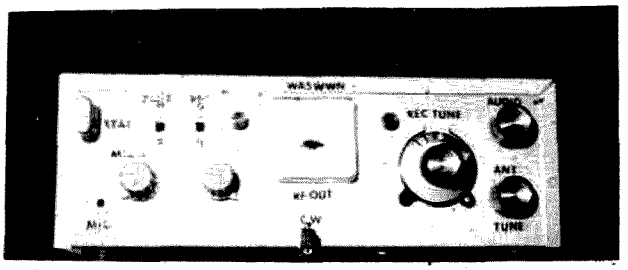
The method presented for transfer of the center loading in an antenna to a more convenient location presents various interesting antenna construction possibilities aside from the one described.

If a location is used where no adequate ground connection is possible, it would seem possible to use the reactance transfer idea to resonate the antenna in a ½λ mode. The base of the antenna would then be at a high impedance point and an antenna coupler would be necessary to couple to a coaxial transmission line. Another approach to make an antenna with less ground dependence would be to form a dipole antenna, center loading each element via a reactance transfer cable to the center of the dipole.

Removing the physical reactance a distance away from the base of the antenna presents the problem of line radiation which was mentioned. A possible solution to this problem may be the use of triaxial cable with the outer shield grounded and the inner shield and inner conductor used for the reactance transfer. How long the cable could be while still retaining good loading Q and without having the tuning become too critical are questions that only trial and error experimentation can answer.

. . . W2EEY/1 ■

Charles O'Grady WA5WWN
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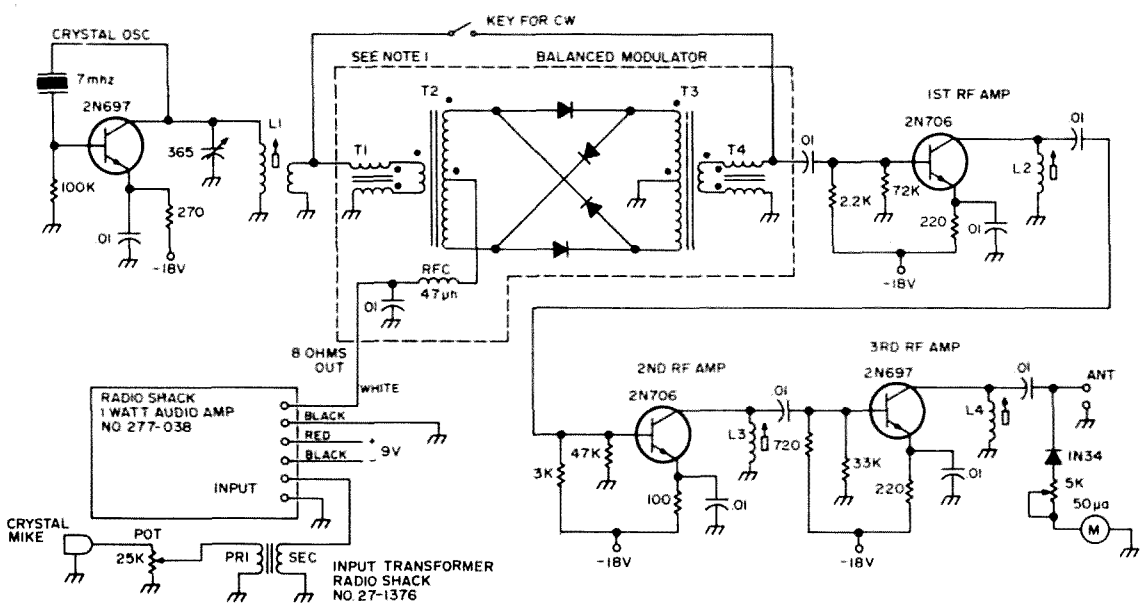


Quazar QRP 40 Meter DSB Transmitter

For several years now I have been trying to make a QRP sideband rig and finally achieved this with the aid of the March 1969 issue of 73 and the article written by WA1FRJ. I had gone through about five different balanced modulators over a period of the past two years and could not achieve any satisfaction until using his method with the toroids. Keeping 18 volts on the transmitter, no carrier is noted. A 20v and above carrier can be observed on the rf output meter that is incorporated in the transmitter output. The diodes in the modulator do not seem to be too critical, but keep the forward resistance of each diode as close as possible. I used the usual junk box diodes from a printed circuit board I bought for 29¢ and with no designation on them (same goes for the direct conversion receiver I built out of another article). Possibly the hot carrier diodes may work better but I have achieved good results with WA5NTN who is about a mile from me and has worked patiently in testing the transmitter for the past three months.

The rig works good on CW, too. I have made quite a few contacts and several contacts over 200 miles. With a little patience one could do quite a bit better I'm sure.

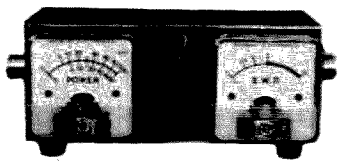
Construction notes: Parts layout does not seem to be too critical. Each section of the transmitter was built on a separate module and tested individually in line as it was constructed. I used 1/16 inch circuit boards and breadboarded the components on each board and made the connections on the under side. This allows positioning of each



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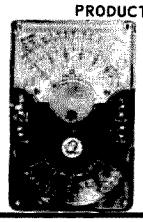
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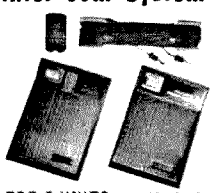
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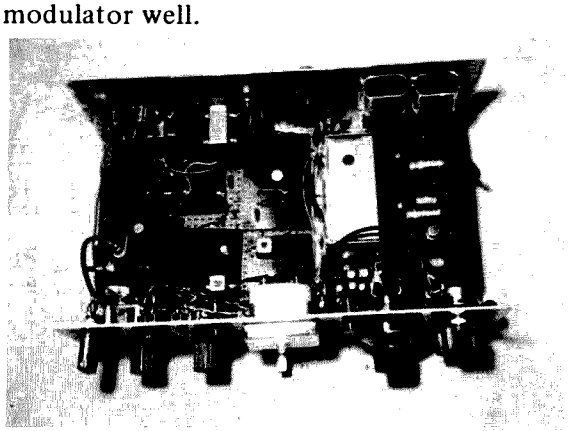
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module where it best fits in the desired cabinet. The coil winding data on the rf amplifiers was just a guess and it turned out that each coil could be peaked to maximum. The audio amplifier is a one watt unit and was purchased at Radio Shack. It seemed easier to buy than build the unit. And the output impedance matches the balanced modulator well.



When tuning the transmitter, a one time tuneup procedure is used. Have the antenna connected and tune up each stage in succession. No external tuning is provided.

. . . WA5WWN ■

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When I started on six meters in 1963, I naturally had my share of TVI. So I built the low pass filter for six meters from the *Radio Amateur's Handbook*[1]. This did help but didn't eliminate all the complaints. Also it had about 2-3 db loss besides. So I really wasn't too happy with it but suffered the loss in order to stay on the air.

Then, about two years ago, I requested and received several Amperex Application Reports[2]. One of these was Report No. S-124, "Designing Varactor Triplers."

Sounds far out? I thought so too until I looked in the back and saw information for three bandpass filters with low insertion loss and good skirts. The filters are for 50 mhz, 150 mhz, and 450 mhz.

The 50 mhz filter had 0.4 db insertion loss at just under 50 mhz but the nose of the curve was very sharp and appeared to be about 1 mhz wide at 1 db down. So I constructed a filter based on this information, but with less spacing in order to slightly overcouple and broaden the nose of the curve while still keeping good sharp skirts. The result was a filter with a minimum loss of 0.3 db, less than 1 db loss from 50 to 52.5 mhz, and better than 40 db down 10 mhz away.

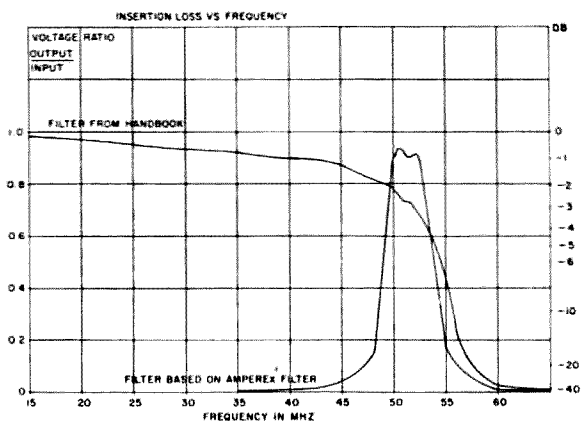


Fig. 1. Graph of filter response.

I plotted the response of both filters in Fig. 1, so you can compare the characteristics. Both filters were peaked for best response and lowest loss at 50.5 mhz. (Note: The low pass was constructed in a steel Minibox which might have added some loss at the higher frequencies.)

The filter is built in a Bud Minibox, CU3003A with all parts mounted on the "U" portion. This is 2½ x 2½ x 4 in. The coils are 7 turns no. 12, 5/8 I.D. One is wound lefthand, and the other righthand. The turns should be evenly spaced and be 1 5/6 in. from the top turn to the bottom turn. Solder directly to the coax connector at exactly one turn from the bottom. For powers up to 500 watts, use Johnson 148-4 capacitors. Above that, use something with a higher voltage rating. Mount the coax connectors at a 45 degree angle to the edges of the box and use a solder lug on the lower screw to ground the lower end of

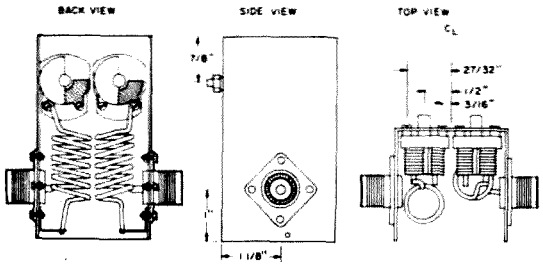


Fig. 2. Filter dimensions and construction.

the coil. When you are finished, the coils should be spaced 1 inch apart. Position as shown in Fig. 2.

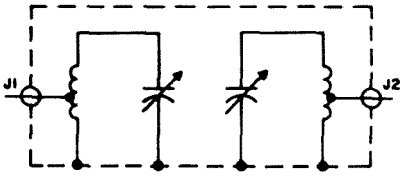


Fig. 3. Schematic.

To tune the filter, insert it in the transmission line, set your receiver to 50.5 mhz, and tune for maximum noise or signal. Then transmit and notice the reduction in TVI. I think you will be quite pleased. Look for me the next time 6 is open, because otherwise I can't get out of this valley. Out here, the dial impulses from the telephone tear up the TV more than my 45 watt homebrew with the filter installed.

. . . WA5SWD/6 ■

Notes

1. *Radio Amateur's Handbook*, page 567, 1965 Edition.
2. Amperex Electronic Corporation, Providence Pike, Slatersville, RI 02876

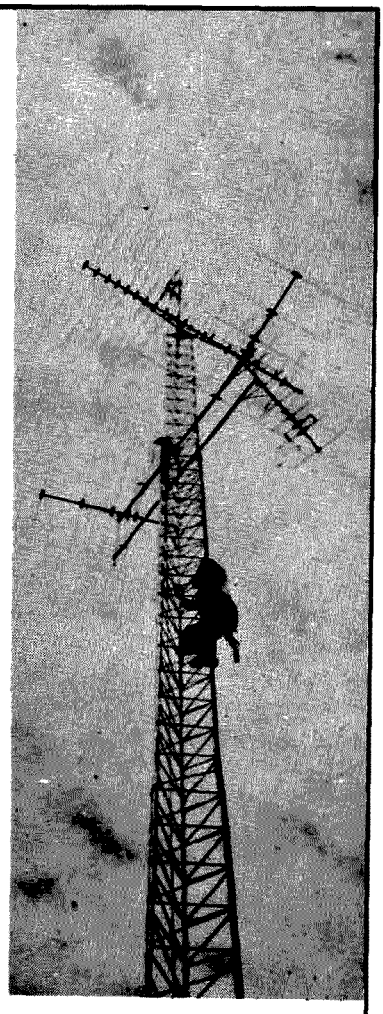
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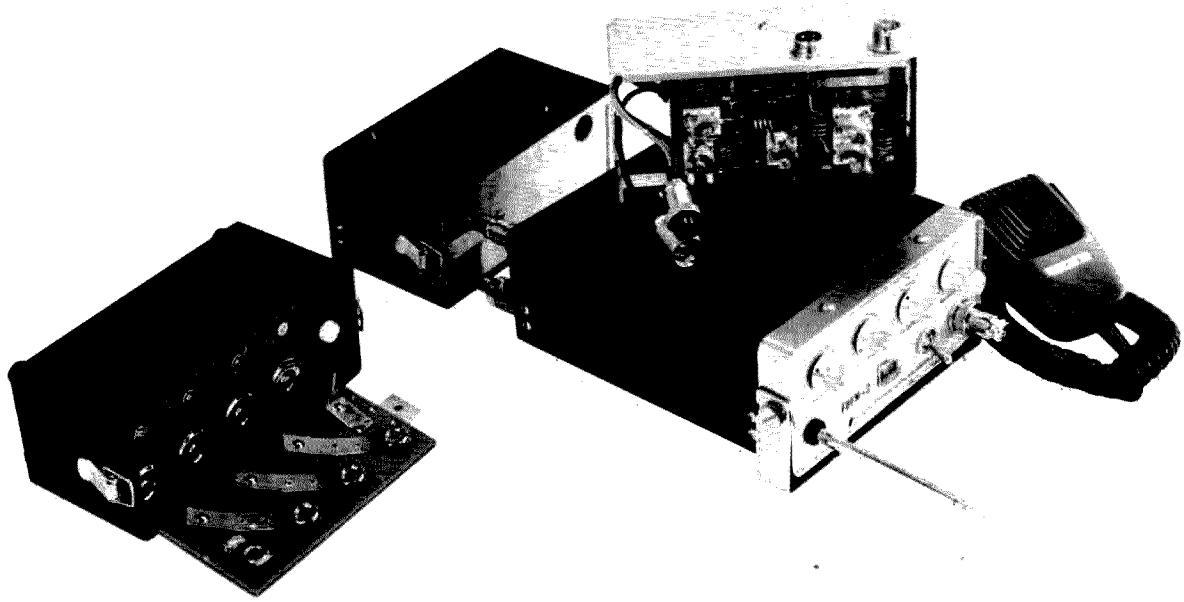


Fig. 1. Varitronics FDFM-2 uses modular approach. Snap-on elements change basic low-power transceiver from mobile to portable, to high-power base station.

Low Cost Electronics: Japan's FM Invasion

Two years ago the door to FM operation on the VHF bands was narrow indeed. The only way an amateur could get started was by converting FM units that were designed for two-way use in the neighboring commercial spectrum. As a result, most amateur FM operators were either endowed with special technological skills or were close friends of individuals who were thus endowed. A survey of operators conducted by FM Magazine in late 1967 showed that 72% of all active FM'ers were associated in some way with the commercial radio service—as technicians, First- or Second-Class Commercial licensees, or as two-way users.

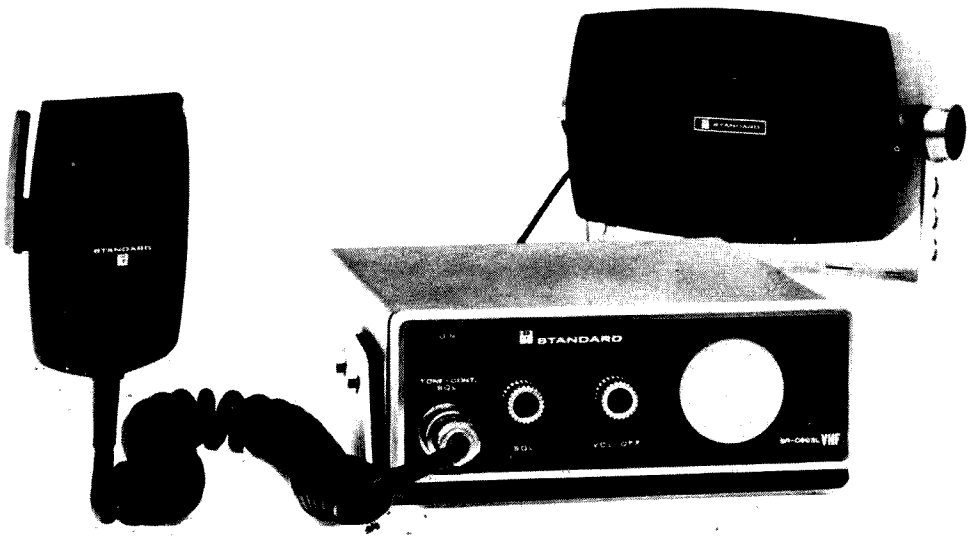
Today, a similar survey would likely show a reversal of that trend. Thanks to enterprising American businessmen and clever Japanese engineers, VHF amateur FM has become one of the least expensive and easiest-to-open doors to ham radio.

The Inoue line of amateur FM units, distributed in the U.S. by Phoenix-based Varitronics, Inc., serves as an example of applied Japanese knowhow. Designed modularly so they can be used in every conceivable application for a variety of individual interests, the units are high power or low; portable, mobile, or fixed; crystal controlled but multiple channel.

The basic unit, shown with three snap-on modules in **Fig. 1**, is an underdash-mounting, six-channel, low-power mobile unit that is ready to go when a 12V source and an antenna are connected. In this service, the transmitter puts a little over a watt into the antenna. And if a watt is insufficient, the module shown behind the transceiver will up the output to better than 20W. The modular class C amplifier mounts flush with the rear of the basic unit and is held on by a suitcase-type snap on each side. (The transistorized amplifier is shown disassembled atop the transceiver.)



Fig. 2. Base station module, built in case of same configuration as transceiver, permits high/low power switching and operation from 115V power source.



The narrowband 12-channel Standard FM transceiver comes equipped with simplex crystals for 146.94 MHz. Designed for portable or mobile operation, unit packs a 5W punch and draws only 100 mA in standby mode. Frequency error rated at 0.0005%, with a receiver sensitivity of 0.3 μV. (Standard Communications Corp., Torrance, California.)

A battery module (lower left in photo) converts the unit to a hand-held transceiver. The battery pack uses eight D-size flashlight cells in series and provides enough sock to keep the radio going for about 15 hours of typical intermittent duty. In portable use, the transceiver stands up on end so that the telescopic whip (protruding from the face of the pictured unit) can be extended vertically. The whip antenna is a screw-on type and is removed for mobile or fixed-station use.

So that the Varitronics FDFM transceiver will be capable of gobbling up every possible morsel of business in the many-faceted FM market, the company is distributing a power supply/amplifier module designed around the same case as the basic transceiver. This unit, shown in **Fig. 2**, contains a converter that supplies 12V dc from an ac source of 115V, as well as a modified version of the class C amplifier. A panel switch permits optional use of the amplifier.

The prevalence of repeaters on 2 meters has opened a whole new vista in useful products for communications. Consider, for example, the limited usefulness of a low-power VHF hand-held transceiver. For point-to-point operation, the range and utility would be restricted to near impracticality except at hamfests, transmitter hunts, and other close-in gatherings. But one of the key features of a repeater is its ability to extend the coverage of even the lowest-powered transmitters and the least-sensitive receivers. Now a number of firms are cashing in on this feature by importing a variety of miniaturized communications devices.

The "Handicom" is one such unit. Designed specifically for use with repeaters, the tiny two-channel transceiver (**Fig. 3**) boasts a receiver sensitivity of 0.4 μV for 20 dB of noise quieting and a transmitter output

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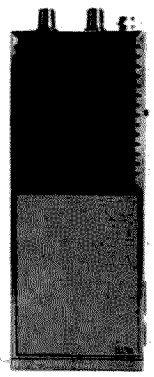


Fig. 3. Handicom transceiver is self-contained 1.6W hand-held unit with sensitive superhet FM receiver, designed especially for operation with repeaters. Comes with two-channel capability so point-to-point operation can be assured when repeater is not in range.



Fig. 4. Allied VHF monitor receiver is one of the first to include the FM portion of the 2-meter spectrum as part of its regular tuning range.

power of 1.6W. The Handicom, distributed by Telco (Pomona, California), comes equipped with rechargeable batteries, charger, integral meter, removable whip, and all the other accessories typically furnished with Japanese-made radios.

Even some of the giants are finding amateur FM a lucrative market. Allied Radio is pushing a low-cost monitor receiver that tunes from the commercial band all the way down to the bottom of the amateur FM spectrum (146.0 MHz). The Allied unit, **Fig.4**, has a self-contained 2-1/2 in. speaker, a swivel telescoping whip, plus provisions for an external antenna and a 115V ac adapter.

. . . K6MVH

Easy Tuning of the Beam

Any time a beam antenna is erected, we run into the problems of how to get to the elements and matching device to tune the beam. **Fig. 1.** shows a method for tilting the boom so the elements are readily available to a man on the tower. Rotation of the boom might be necessary and this is accomplished by loosening the clamps.

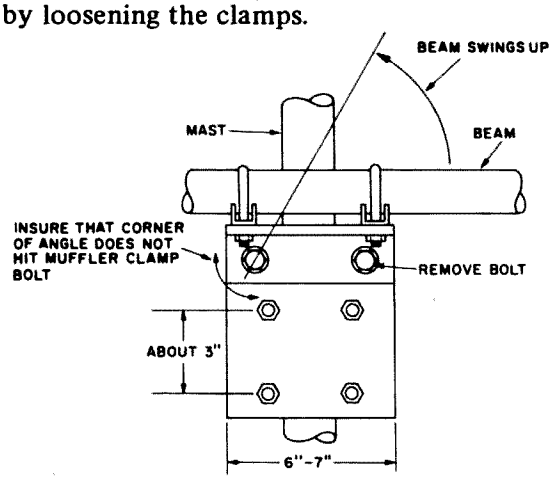
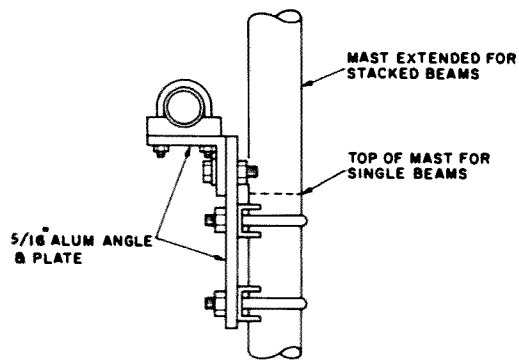


Fig. 1. Construction details of the tilting device.



With one man stationed on the tower, a rope tied to the boom, and the bolt removed, he can bring the elements and matching device within easy reach. Since the beam is off center, it will right itself by letting up on the rope.

...P.L. Simandl, K9SQV

Dial Drive Repair

"The Heathkit SB series of ham kits are, in general, a fine piece of electronic equipment." This is the kind of statement you can hear on almost any ham band where you might listen. There is, however, one bad comment one does hear once in a while: "That darn dial drive." (It must be pointed out that the dial drive is a real joy to most: however, to some...) I became one of the few after building two kits (an SB-300 & SB-400) with no problems. As is normal with such endeavors, it was a kit I was building for a friend that "went amuck." The problem was that no matter how hard I tried to align the thing, the drive would operate for a short time, and then, for no reason, just quit.

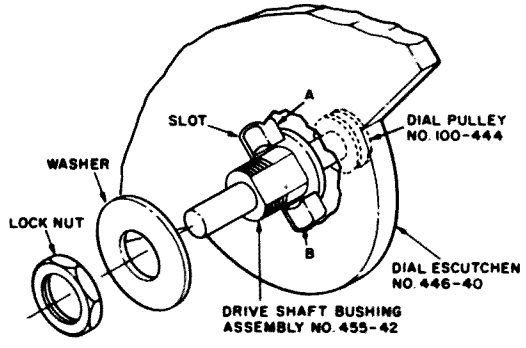


Fig. 1. Cut away drawing showing added "shims" (A&B).

It seems the problem is in the fundamental design. Once the "Dial pulley" (Heath part 100-444) is pressed down and locked in place with a lock nut, sometimes the unit just "walks" up on the slot in the escutchen and slips. (The plastic material used to make the escutchen prevent the builder from making it too snug.)

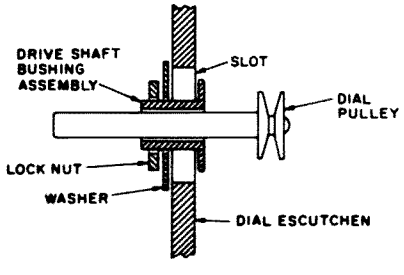
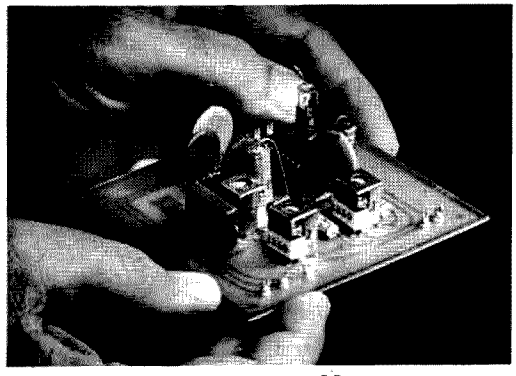


Fig. 2. Profile (No shims).

To eliminate the problem, I simply made two wood shims (one above and one below the "dial shaft bushing assembly") as shown in Fig. 1. This simple addition removes all the stress from the plastic escutchen and allows the dial to operate 100% of the time with the lock nut only "finger tight."

Phil Writer, W6TRU



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Mobile CW

After operating CW mobile in one of the heaviest auto populated sections in the U.S.–the Los Angeles freeways–for over a year and receiving comments from, "how brave you are" to "what an idiot," unspoken but unmistakable, I decided to write about some of the tricks that make mobile CW a real ball.

First, mobile CW is hopeless unless you are a true CW man. You must be motivated to communicate by that wonderful pure code and give up the "by gollies" and "fine business, here" jazz of SSB. Mobile will never convert you to a CW man, but a CW man can be converted to mobile.

Second, you must be prepared to accept the frustration of having your report or the DX call blanked out by the ignition QRN from that miserable little VW who is staying right behind you staring at that big whip. Murphy's law reigns paramount here. When you have been waiting for 30 miles to hook that JT1 just invariably when he calls you, on comes the ignition or power line QRN. You will begin to notice that all the major roads and freeways follow the path of the highest QRN. I am sure they put in the power poles first and built the roads next to them. Also, you will find yourself looking for different ways to drive to work to avoid what I call "QRN Alley" or else you time your QSO so you send in the high QRN areas and receive in the low–tricky, but possible.

The basic solution is simple. Acquire the patience of Job and train your ears (what the headshrinkers call "the cocktail party syndrome" where you can pick out one voice and copy it solid over other masking voices) to copy through S5-S7 QRN and develop the tricky use of audio filters, rf, and audio controls. The code can sound mighty strange by the time it gets through all those windows, but it can be copied solid. As a bonus, your home receiver will sound so very nice and quiet to you that you keep checking to see the antenna is connected–sort of like after you lift heavy weights for a long time then light weights seem very light. All this is for free.

Third, you must be prepared for strange looks, staring kids, and slow shaking of heads as people pass you on the freeway. Especially when your car is a white Cadillac, the whip sticking way up high as it is mounted on the center of the car just back of the rear window forward of the trunk deck, earphones on, and then have a beard–like me. I have a speaker mounted by my left ear, but as I like to chase DX even mobile, I use phones–in fact, I most always use phones as a hangover from the "every signal is weak" old days. If you are shy–forget it.

This article describes what could best be called a "human factors approach." It is not a construction article, as many excellent ones have already been written, but it shows one way to integrate the amateur, the driver, the car, the freeway, and the rig all into one smoothly operating loop to dramatically lessen the hazard of operating CW while driving.

My basic "human factors" design requirement for CW mobile operation was the rig and all controls had to be operated without the driver ever taking his eyes off the road. To do this, all controls must be close enough to the driver and capable of operation without reaching *or* looking to reach.

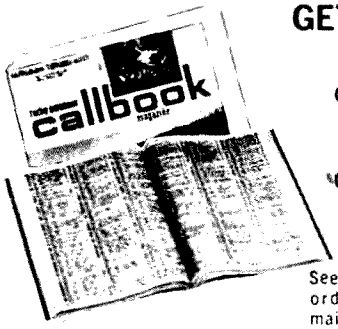
As each mobile installation is different, the first step is to make what the aerospace industry calls a "mock-up," or a simulation of the rig, controls, and mounting in the car. This can be done by supporting the rig, controls, SWR unit, etc., with wood blocks, rope, books, beer cans, etc., and using stiff cardboard and tape to simulate the structure of mounting of the final installed operating position of the rig, the key or paddle, and

SWR unit in the front seat of the car.

Then, the second step is to shut the doors, move the seat to the driving position, start the car and operate all the car controls like the lights windshield wipers, steering wheel adjustment, air conditioner controls and outlets, ashtray, glove compartment—don't miss a one. Obviously, in all cases they should not be completely obstructed by the rig or supporting mounts. In specific cases, a compromise can be made. In my installation the governing factor was the dashboard ashtray. I compromised on using half of it. I pull it out until it hits the rig and that gives enough clearance to use the lighter and half of the ashtray. I don't smoke while driving, but girls do!

The third step is to simulate a complete QSO operating all the rig controls and key with your eyes doing just the normal (?) scan of odometer, fuel and temperature gauges, rear mirror, side mirror, and the blonde in the next car. In no case look at the rig—except for the first quick glance to see if you are in the band. To do this with a flick of the eye, mark on the dial in black with

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tape or paint a ½ inch bar at each band edge so as long as you are centered between the black bars you are safe. Now, make the final adjustments to the "mock-up" so the basic design objective is met; i.e., operation of *all* controls without looking or stretching to reach them.

Great—if you feel silly after this little experience, then you did it just right, but you would be amazed at how much time and money is spent and how seriously such simulation is done in the aerospace industry.

My installation, which resulted from the "mock-up," was a little wooden desk made from soft pine. The desk bottom is contoured to fit over the floor hump and is secured to the car floor with angle brackets. The art of drilling through the car floor into a clear space for nuts and washers underneath is sheer black magic. However, some judicious measuring from the car edges or other reference point helps not drilling through the muffler or a brake line.

The desk is made so the Swan 500 sets into a recess on top placing the front panel on a slanted plane easily reachable and seeable from the normal driver's position. The rig is held down in the recess with one bolt and a wing nut.

The desk has a small "L" shaped flat top going in front and along the left side of the rig. The front portion holds a paper pad and the left hand side of the "L" has the vertical plane of the right edge of the steering wheel. Thus the driver's hand just slips off the wheel onto the desk and the fingers drop on the key and paddle with an arm rest. The hand key and the keyer paddle are mounted in the same position on the desk. The keyer paddle is mounted vertically at an angle above the hand key so the paddle finger plates are forward and above the hand key knob—just far enough away so the fingers can handle the hand key without hitting the paddle plates. In this manner when your hand falls off the wheel, your fingers are on both the paddle and the band—so without looking you can move your fingers to work whatever key you want. Both keys are installed so if the keyer flunks the course, you still are on the air with a hand key to get in practice for the Extra Class exam. The SWR unit is mounted on the top and back of the Swan 500 where it is visible by glancing over the top of the rig toward the car floor.

All other controls, like the keyer speed control, speaker switch, etc., should be on the left side of the steering wheel to balance up the human factors programming of the rig operation on the right side. An added refinement is to duct some cool air from the air conditioning ducts into the final tube compartment of the rig. After an hour's operating even the dial on the Swan 500 would be hot to touch. After building a plenum chamber on the outside of the enclosure right next to the final amplifier tubes and installing a duct from the air conditioning system, the whole rig is cool. This lets the power output stay up and must prolong component life. Even the use of ambient air from the blower alone has significant effect. So far, no one has commented on the fact I disconnected the entire car's right hand air conditioning for this worthy purpose! It is an interesting and uncomfortable example of thermodynamics to feel how much heat can be transmitted into the front seat area from a little black box burning up those watts not going into the antenna.

If you have been faithful to the design objectives, you now have a "human factors" designed mobile installation. You should be able to turn on the rig, tune and establish control without looking or reaching so your head bobs down. In the real world you will find many clear opportunities to look while stopped in freeway jams, but you will be amazed at how quickly you can scan everything you need to see.

One word of warning while driving: By all means avoid the trap of looking at the rig and trying to troubleshoot if it doesn't work. The feeling is almost irresistible to try to get it working again—right now. Don't do it! Shut off the rig and listen to AM/FM until you get home or else get off the freeway and stop. It cost me $450 over the deductible insurance one rainy night on the freeway trying to get the rig working. It started working just as I slid off the side and down the embankment—a sadder, but wiser CW mobile type. Human factor engineering helps, but it can't think for you.

. . . K6RA■

Getting Your Extra Class License

STAFF

Part XII: Semiconductors

Just a little more than two decades ago, a trio of Bell Telephone Labs researchers put together a device which had all the external characteristics of a resistor—with one thing added: it would transfer a signal from one circuit to another, and if the circuit was properly put together it would amplify the signal in the process.

The learned gentlemen coined a name for their device by combining the words "transfer" and "resistor" into "transistor." Today, it's hard to realize that the transistor was unknown 25 years ago, and even 15 years back was pretty much a laboratory curiosity. Now, of course, it's just about the usual thing to find transistors in almost any receiver, and not too unusual to find them in low-power-level stages of a transmitter as well.

Semiconductors—of which the transistor is only the most widely used example—are such an important part of the art of electronics today that the Extra Class examination includes a number of questions dealing with them. Those questions are our subject this month.

The official FCC study list of questions includes five specific questions dealing with semiconductors in its total of 90 questions covering the entire knowledge required for would-be holders of the Extra Class ticket. These questions are: 15. Define the alpha cutoff frequency of a transistor. How is this parameter of use in circuit design?

38. How are the emitter, base and collector of a transistor biased for amplifier operation? How are they biased for cutoff (open circuit) and saturation (short circuit)?

39. How do NPN type transistors differ from the PNP type? How does their bias differ?

52. What is the phase relation between the input and output signals in the common-emitter, common-base, and common-collector transistor circuits?

84. Compare silicon and vacuum tube diodes. What is meant by the "forward voltage drop" of a conducting silicon diode?

Question numbers, as always, are those assigned in the Commission's study list.

We'll follow our usual procedure. Rather than answering these five extremely specific questions with equally specific replies, we'll reword the questions into less specific queries which cover the same material but much more as well. Then we'll hunt for answers to our more general questions, and along the way come up with the answers to not only the specific study list questions, but most of the similar ones which may appear on the actual exam.

All our questions deal with semiconductors, so let's make our first general question simply "Why Is A Semiconductor?" The answer to this will provide answers to both questions 39 and 84, as well as a foundation for our subsequent questions.

From there, let's find out "How Do Transistors Amplify?" This will provide partial answers to questions 38 and 52, as well as to the second part of question 39.

When we know how transistors amplify, then we can ask "What Factors Affect a Transistor's Amplification?" and that will bring us into the answer for question 15. To wind up our examination of transistors, we'll ask "Is Amplification All?" and that will get us an introduction to the world of semiconductor switches. This subject in itself could fill several large volumes, but affects only a part of question 38 on the study list.

For our final question, we'll drop transistors and ask "How About The Rest Of The Family?" Here, we'll take very brief looks at some other members of the semiconductor clan and compare them with their more historic equivalents.

As always in this study course, we run the risk of oversimplifying complex subjects when we attempt to compress an entire field of study into one or two articles. This time, the risk is higher than usual—because semiconductors came to us from physicists rather than from more mundane experimenters, and the whole basic theory is deeply intertwined with the physics of subatomic particles.

Fortunately, nobody needs to be an atomic physicist to get a fairly clear understanding of how semiconductors work. This was made abundantly clear more than 10 years ago with the publication of Department of the Army Technical Manual TM 11-690, "Basic Theory and Application of Transistors." In that 253-page volume, only one chapter required any knowledge of mathematics—and that chapter could be skipped without any harm at all, because its purpose was to provide the algebraic proof that the "equivalent circuits" used by transistor-circuit design engineers actually do represent transistors accurately. And the math required to get through that single, optional chapter was hardly any more complicated than that necessary to apply Ohm's Law!

We have leaned heavily upon the approach and examples used in TM 11-690 in preparing the first 4/5 of this installment, because the basic theory has not changed and 11-690 does provide an accurate picture of it without introducing errors because of oversimplifying. The final discussion, though, involving "the rest of the family", is based upon a number of other sources, because the kinds of semiconductors known have increased hugely in the decade since 1959.

Why Is A Semiconductor?

To have any understanding of how a transistor operates, we must have a fairly clear idea of what a semiconductor is and why it can operate. But to get that idea clear, we must first turn our sights to something even more basic—the theory of the structure of matter.

We already know quite a bit about this theory, although we may not know it by name. It's the theory which tells us that electrons exist!

Let's start out assuming that we know nothing about it, though, and begin at the very beginning by defining "matter" as "any substance that has weight and occupies space." This includes all gases, liquids, and solids.

Chemists tell us that all matter is composed of either "elements" or "compounds," with most of it being "compounds." An element is a substance that can neither be broken up into other substances by chemical action, or made from other substances. A compound is any substance which is not an element. Such things as copper, aluminum, oxygen, and hydrogen are elements. Water, rust, and salt are compounds. Water is a compound of two parts hydrogen and one part oxygen, but its chemical properties are very different from those of either of its elements. Salt is made of equal proportions of the metallic element sodium and the gaseous element chlorine, both of which are highly poisonous in their pure form—but salt is essential to life.

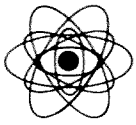
Whether a substance is an element or a compound, it is made up of many "molecules." The molecule is the smallest particle of any substance which can exist by itself and still retain its chemical properties. The molecule is composed of atoms, which are the smallest particles of *elements* that can take part in chemical actions. A molecule of water contains two atoms of hydrogen and one atom of oxygen. A molecule of gaseous hydrogen contains two atoms of hydrogen. A molecule of salt contains one atom of sodium and one of chlorine.

Since there are at least 102 elements, 92 of which occur in nature and the rest of which are man-made in nuclear experiments, there are at least 102 different kinds of atoms. At one time it was thought that the atom was the smallest particle of matter—but the advent of our electronics art brought that belief to an end. To explain the action of electricity and vacuum tubes, the physicists had to move on into the world of subatomic particles.

By now, they have moved still another step smaller into "subnuclear" particles as well, but we don't need to carry things that far. Our purposes will be adequately served when we meet the three major subatomic particles: the electron, the proton, and the neutron.

Nobody has actually seen any of these, so what follows is only theoretical. The theory, however, has withstood the test of time since 1889, and has fit all observations, so we assume that it is an adequate picture of the atomic structure.

If we could enlarge an atom some 100 million times, it would appear to be about the size of a penny. We could then distinguish its two major parts (Fig. 1), which are a central nucleus and a cloud of electrons orbiting around the nucleus much as the planets of our solar system orbit the sun.



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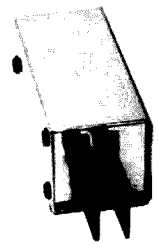
Fig. 1. Atom is smallest unit of any element. Views shown here are those described by current atomic theory; nobody has ever seen either so they may not be correct. Top view shows major parts of atom—central nucleus and orbiting clouds of electrons surrounding it. Electrons orbit in "shells" which represent definite energy stages. Nucleus is composed of neutrons and protons as shown in lower view.

At a billion time enlargement, we could see that the nucleus resembles a bunch of grapes, and contains two different kinds of particles. This part of the atom provides nearly all its mass. Both kinds of particles in the nucleus weigh the same—1850 times as much as the electron. One of the particles is charged while the other is neutral; they take their names (proton and neutron) from this fact. The proton has a positive electrical charge.

The positive charge of each proton is balanced by an equal negative charge on the electron. It's still an open question just what an electron is; some feel that it's merely a

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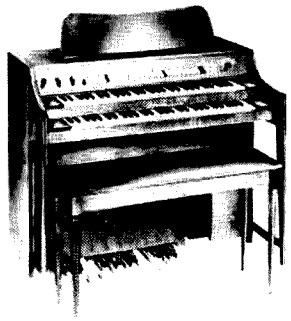


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unit of electrical charge while others feel that it's more than that. For our purposes either idea is all right, so long as we remember that the atom is balanced electrically.

The electrons are held in their orbits by a balance of opposing forces, including electrical attraction and repulsion. The orbiting electrons shield the nucleus so that it cannot take part in ordinary chemical reactions, but the number and kinds of particles in the nucleus determine the mass of the atom and how many electrons it has, and so are the factors which make one element different from any other element.

In some respects, the cloud of electrons in any one atom is something like an onion. If you keep peeling an onion, you'll never get below the skin—and when you finish you'll find you have nothing left.

Similarly, the orbits of the electrons in each atom are arranged in layers sometimes called "shells." Each shell represents a balance of forces at a specific distance from the nucleus, and each shell can hold only a specific number of electrons. The first (innermost) shell can hold only two electrons. The second shell can hold only eight. The third is limited to 18 electrons, and so forth. If an atom has only one or two electrons, it will have only one shell. If it has 3 to 10 electrons, it will have two shells. With 11 to 28 electrons, three shells are necessary. The outermost shell need not be filled.

Because of repulsion between like charges (and all electrons are negatively charged), the outermost shell (Fig. 2) is the only one able to participate in chemical reactions. Chemists call it the "valence shell," and know its electrons as the "valence electrons," for this reason. The number of valence electrons in any atom determines how that atom will combine with other atoms to form molecules. For instance, hydrogen has only one electron, but the first shell can hold two electrons. Because of this, hydrogen atoms combine to form hydrogen molecules of two atoms each, with each of the atoms in each molecule sharing its electron with the other. Both positions in the shell are now filled, and additional chemical combination is difficult.

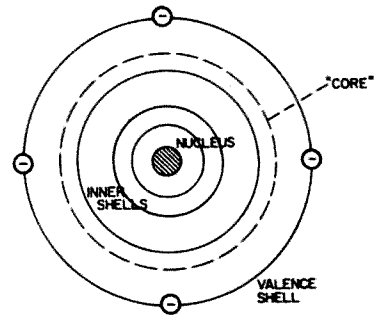


Fig. 2. General structure of atom as it applies to semiconductors is mapped here. Nucleus, in center, is surrounded by electron shells. Outermost shell, termed "valence shell," is only one involved in crystal structure or chemical actions. Nucleus and all inner shells, combined, are called "core" of atom. In crystals, atom cores are fixed into position but valence electrons are free to move to limited degree.

The various kinds of matter may be divided into groups in many ways. We have already seen the physicists' grouping into gas, liquid, and solid. Chemists group things as elements or compounds; they also group by "organic" and "inorganic" structure, in which organic structure includes all compounds containing the element carbon, and inorganic structure is everything else. We will be concerned only with matter of inorganic structure from here on; this eliminates anything which was once part of a living organism.

Another grouping, which is why we've gone through all this in the first place, is into the categories of "conductors," "insulators," and "semiconductors." This actually isn't a very good set of words to use, because no perfect conductor or perfect insulator exists. Everything, actually, is a semiconductor—but some things are more, and some things less, "semi" than others.

Copper, silver, and gold, for example, are considered good conductors because they offer extremely low resistance to the flow of electric current. Air, glass, and mica, on the other hand, are considered insulators because they offer extremely high resistance.

The resistance of any substance is directly related to the valence electrons in the molecules of that substance. If the electrons are relatively independent of any one nucleus, they can migrate easily through the material—and that material is a good conductor as a result. If, on the other hand, the electrons are tightly bound into place and there are

few "free" electrons able to move, then the resistance will be high and we have an insulator.

Our common semiconductors, germanium and silicon, are actually fairly good insulators in their absolutely pure state. They gain their semiconductor properties because of carefully controlled impurities which provide a few free electrons or their equivalent—but before we can see how this is done we must turn from chemistry to physics and look at the structure of crystals.

Most solid inorganic substances are made up of crystals. In many cases the individual crystals are too small to see except through a microscope, but in some cases the crystals are large. A quartz crystal in its natural state (before cutting) is a single large crystal. So is a diamond, or the ruby rod in a laser.

X rays have been used to examine the internal structure of crystals, and from the pictures obtained we have been able to construct models of this internal structure. These models reveal the not-too-surprising fact that the structure of the crystal is determined by the characteristics of the atoms which compose it (not necessarily the molecules), and the somewhat less expected point that each atom is related not to just one adjacent atom or two, but to a number of adjacent, equidistant atoms.

The specific arrangement of atoms in any crystal depends on the size and number of atoms present and on the electrical forces between them. All other characteristics of the crystal depend on these forces between the atoms.

For instance, to turn to carbon crystals momentarily, the carbon atoms in a crystal may take either of two different arrangements. One of them produces a structure which is soft and opaque; we use it (graphite) as a lubricant and to write with. The other produces a structure which is the hardest substance known, and is transparent. Only another diamond will cut a diamond. And the difference between a diamond and a pencil lead is just the difference in arrangement of atoms of the same element.

The structure of a crystal is determined by the valence electrons of the atoms in the crystal. In a crystal, the rotation of one valence electron of a given atom is coordinated with the rotation of one valence electron of an adjacent atom. Such a coordinated rotation of two valence electrons (one from each of two adjacent atoms) is called an "electron-pair bond" by physicists, or a "valence bond" by chemists.

The electron-pair bonds cause the nucleii of the two atoms involved to be attracted toward each other, while the positive charges on the nucleii repel each other. When these forces of attraction and repulsion balance, the crystal structure is in "equilibrium."

Once a valence electron is involved in one electron-pair bond, it cannot participate in any other such bonds, nor may it drift through the substance as a free electron. Thus, in a crystal, each valence electron of each atom can form an electron pair bond with an adjacent atom.

The first element widely used as a semiconductor, and still one of the most popular, was germanium. This element has four valence electrons in each of its atoms, and so each atom in a crystal of germanium is linked by electron-pair bonds to four adjacent atoms. The resulting crystal structure looks something like the sketch in Fig. 3, with one atom at the center of a pyramid and its partners at the corners of the pyramid.

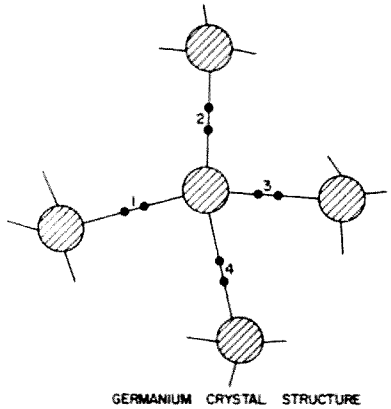


Fig. 3. Germanium and silicon, the two most widely used semiconductor materials, each have four electrons in their valence shells and so form crystals in which each core is joined to four other cores by electron-pair bonds. Other materials may also fit into the structure, with electrons either missing from bonds (holes) or left over (free). This produces P-type and N-type material, respectively.

We have already seen that crystals may be small or large. The crystal structure we have just examined is that which exists *inside* the

crystal; at the edges, of course, there are no adjacent atoms to link to. Because of this, materials which exist as many small crystals (such as most metals) behave considerably differently from those which exist as a single large crystal. In particular, a polycrystalline (many-small-crystals) substance is likely to be a good conductor because the valence electrons in the outside atoms of each crystal are free to drift through the materials, and a single-crystal substance is likely to be a good insulator because almost all its valence electrons are fixed in place as partners in electron-pair bonds.

What we call semiconductors are always single-crystal substances. If every atom in a crystal of germanium is actually a germanium atom, then the crystal acts as an insulator. However, if a very few (about one in ten million) atoms of some other substance with either fewer or more than four valence electrons are in the crystal, the valence electrons will not all be fixed in place.

A number of such other substances are able to fit into the structure of the germanium crystal. Arsenic, phosphorus, antimony, and boron, all of which have five valence electrons rather than four, will fit in. So will aluminum, gallium, and indium, which have only three valence electrons.

The substances with five valence electrons are called "donor" materials because they "donate" an excess valence electron to the crystal. A crystal containing donor impurities has a surplus of electrons and so is inherently negative in charge; it is called "N-type" germanium.

The substances with only three valence electrons are called "acceptor" materials because they "accept" only three electron-pair bonds and leave a "hole" which may be filled by any stray electron. This absence of enough electrons to fill all the possible bonds in the crystal results in a positive-charge characteristic, and such a crystal is called "P-type" germanium.

It's important to remember that the crystal *as a whole* is electrically balanced in either case, because the donor or acceptor atoms were electrically balanced before they became part of the crystal structure. The "positive" or "negative" imbalance we spoke of in the preceding two paragraphs refers only to "free" particles which are able to drift within the crystal. N-type crystals have electrons which are free to move without disturbing the crystal structure, while P-type crystals have "holes" which may be filled by electrons introduced from outside. Of course, whenever a hole is filled, the crystal itself has too many electrons for balance and must get rid of one, which produces a hole somewhere else, so that the original hole appears to drift through the material just as would the free electrons in N-type material.

Either P-type or N-type germanium is a better conductor than pure germanium would be, because the impurities provide either free electrons or free holes which can carry electric charge through the material. The free electrons or holes are called "charge carriers" or just "carriers" for short.

Now that we have seen how charge can move through the structure of a semiconductor crystal in the presence of impurities, we're ready to look at the reasons a semiconductor can work as it does. First, let's look at a diode.

If we take a crystal of N-type germanium and connect a battery in series with it, a current will flow. It is carried through the crystal by the free electrons in the crystal structure.

If we use a crystal of P-type germanium instead, the same thing will happen, with the holes carrying the current through.

If we disconnect the battery from both crystals, no current will flow. The atoms inside each crystal would be vibrating because of heat energy which is always present, and the carriers in each crystal would be "diffusing" at random throughout the structure, but nothing would escape from the edges of the crystal.

Now let's join these two separate crystals to form a single crystal, which is N-type at one end and P-type at the other end.

We might expect the holes in the P-type to move toward the junction, in their random diffusion, and there meet the electrons from the N-type, combine into a filled electron-pair bond, and thus eliminate all carriers from the crystal.

This process actually starts to happen

when we form such a crystal—but it stops itself soon after it starts, and long before all the carriers are eliminated from the crystal. When a hole from the P-type and a free electron from the N-type join to form a new electron-pair bond at the junction, this leaves a nucleus short one electron in the N-type material, and a nucleus with one electron too many in the P-type region. The charge across the junction is no longer balanced. The next free electron which diffuses toward the junction is repelled by the excess negative charge now present in the P region, and cannot get to the junction to join with a hole.

So long as any point exists at the junction where holes and electrons can meet without repulsion, they will do so—but as soon as every electron-pair bond across the junction has been filled, no more carriers can cross the junction because of the "barrier" established by charged nucleii just outside the junction area. This barrier area is known as the "depletion region" (Fig. 4) and also as the "space charge region." It has definite physical width.

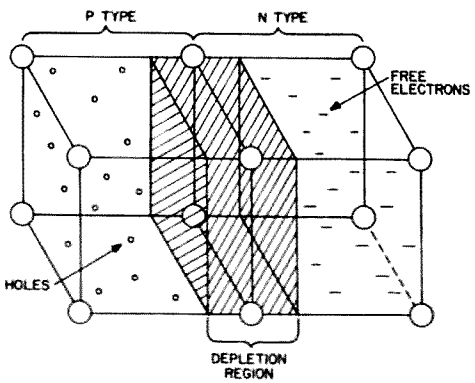


Fig. 4. When P-type and N-type material are joined into a single crystal structure, holes and electrons recombine at the junction to form a barrier or depletion region, shown shaded here. Holes are concentrated at P-type side of barrier and free electrons are at N-type side. Crystal as a whole is electrically neutral, however.

The unbalanced nucleii which establish the barrier are (or may be considered to be, which amounts to the same thing) near the outer edges of the depletion region; since all the electron-pair bonds within the depletion region are filled, this area acts as an insulator—and we have, in effect, a charged capacitor *inside* the crystal.

One way of defining voltage is in terms of the amount of charge in a capacitor. Normally, this is a sort of "reverse English" manner of defining voltage—but in this specific case it lets us think of the barrier in terms of voltage, and this equivalent voltage defined by the charge surrounding the depletion region is known as the "height" of the barrier.

For any particular junction, the height of the barrier depends upon many things. Some of these things are the amount of impurities present in the crystal structure, the temperature (which determines how much bouncing about inside the crystal the carriers may do), and the amount of light reaching the crystal (which provides energy, just as does heat). The most important, though, is the material of which the crystal is made. The barrier in any germanium crystal junction runs between 0.2 and 0.3 v in height, while that in a silicon junction runs between 0.6 and 0.7 v height, in the absence of any external forces.

It's important to remember that the barrier comes into existence when the junction between N-type and P-type material is formed in a single crystal. It's always there. Whenever we have a junction, we have at the junction a depletion region and a barrier. The barrier height depends upon the crystal, but is somewhere around half a volt in most cases in the absence of external forces. Now let's see what happens when we connect *this* crystal to a battery.

Let's try it first with the positive pole of the battery hooked up to the N-type end of the crystal. The battery provides electrons at its negative terminal and forces them into the P-type end of the crystal. This fills even more holes in the P-type material, while the positive terminal of the battery is drawing electrons out of the N-type end of the crystal and so is taking out even more free electrons than were already used to form the depletion region.

As free electrons are drawn out of the crystal toward the positive pole of the battery, the random diffusion within the N-type material tends to move them away from the barrier to fill the gaps. Similarly, the holes in the P-type material move away from the barrier to replace the holes filled by electrons from the battery. The net result

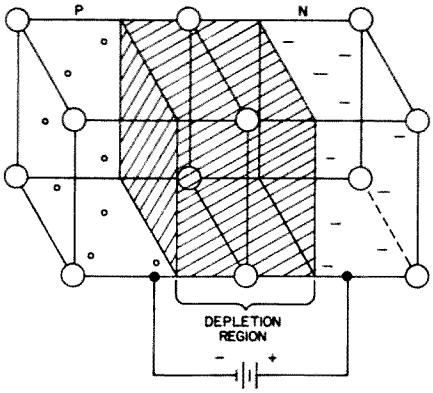


Fig. 5. Battery connected as shown here supplies more electrons to fill holes in P-type end of crystal, and withdraws free electrons from N-type material. Result is widening of depletion region until voltage across barrier equals voltage of battery, or until crystal structure breaks down if voltage is too great. Condition is known as "reverse bias."

is that the depletion region becomes physically wider—and the barrier becomes higher. This process continues until the height of the barrier exactly equals the voltage of our battery. When this occurs, no current can flow, because the voltage of the battery is exactly balanced out by the height of the barrier at the junction.

Under these conditions (Fig. 5), our junction is an insulator.

If we reverse the connections to the battery, though, things change. Now, every time a free electron and a hole combine at the junction, they are replaced by a new electron put into the N-type end of the crystal from the negative pole of the battery and a hole created in the P-type material by the battery's taking away an electron. This *reduces* the width of the depletion region

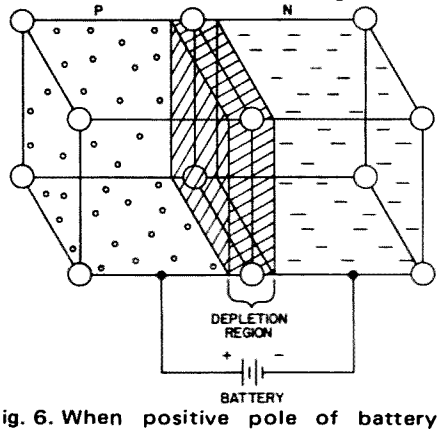
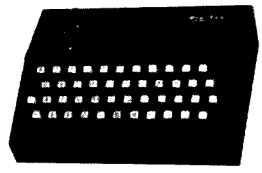


Fig. 6. When positive pole of battery is connected to P-type end of crystal, battery supplies free electrons to N-type and draws electrons out of P-type to produce more holes. This narrows the depletion region and reduces resistance of crystal structure.

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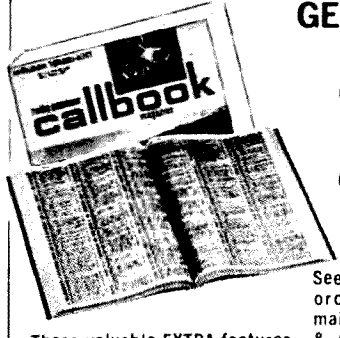
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(Fig. 6) and the height of the barrier. It does even more—when the barrier is completely overcome, it makes the crystal into an excellent conductor.

The junction, then, is effectively a polarity-sensitive switch. For current flow in one direction, it is an open circuit, but if current attempts to flow in the reverse direction it turns into a conductor.

Such a device is, by definition, a diode and a rectifier. If we apply ac, instead of using our dc battery, the polarity will reverse every half-cycle. Those half-cycles which oppose the barrier are blocked, but those which reduce the depletion region width go through unchallenged—and the output is pulsating dc.

We call the open-circuit condition "reverse bias" and the closed-circuit condition "forward bias," the "voltage drop" of a junction diode is simply the barrier height, because even in the forward-bias condition the applied voltage must overcome the barrier before the depletion region's width drops to zero and closes the switch.

It is possible to force current through a reverse-biased junction diode; if the applied external voltage is so great that the entire crystal is used by the depletion region, for instance, any increase in voltage cannot be overcome by additional expansion of the depletion region. In such a case, the crystal structure actually breaks down and current flows unchecked. If the current is limited by something outside the crystal so that excessive heat cannot be generated, the breakdown heals automatically when the overvoltage is removed; if nothing limits the current, the crystal material is usually vaporized by excessive heat. Zener diodes make use of this reverse breakdown, but in most cases it's something to avoid; that's why diodes are rated for "peak inverse voltage" or "PIV"—that's all they will stand in reverse!

Most rectifier diodes now in use are of silicon rather than germanium, but they work in just the same way. The reason silicon is used is that it is much less temperature-sensitive than germanium, and has higher resistance when reverse-biased. The reverse resistance of a good silicon diode may be greater than 10 megohms, while the resistance in the forward direction is usually less than 500 ohms.

A part of the voltage drop associated with a silicon diode is simply the result of Ohm's Law, because of the 500-ohm forward resistance. However, the forward resistance varies with the amount of current flowing, so that the voltage drop is hardly ever more than a volt (the barrier in most silicon rectifier diodes averages 0.65 volts without current flowing). In fact, it's necessary to put current-limiting resistors in series with silicon diodes to keep them from destroying themselves in normal operation, because they will permit extreme current flow in the forward direction. These resistors are usually 47 ohm 1/2-watt units, which serve the purpose adequately in most cases.

The action of the silicon is a direct result of the crystal structure including the junction between P-type and N-type silicon. This is different from a vacuum diode, which boils electrons off a heated cathode and permits them to flow to the plate whenever the plate is more positive than the cathode. The major differences which result from the different action are:

1. The vacuum diode requires power to heat the cathode while the silicon diode does not.

2. The vacuum diode requires an envelope to maintain its vacuum; the silicon diode is a single crystal and can be quite small.

3. More force (external voltage) must be applied to move electrons across the distance between cathode and plate in a vacuum diode than is necessary to move charge across the junction in a semiconductor, because of the 10-million-to-one variation in the distance (atomic in the case of the junction, easily visible in the vacuum diode).

4. The heater in the vacuum diode eventually burns out; the semiconductor diode has no known failure mechanisms which are inherent in the unit itself, and most failures are caused by failures of other items in the circuit. No semiconductor has ever been known to "wear out" with use.

Most of these differences are also applicable when comparing vacuum tube amplifiers to transistors—but that's our next subject. At this point, we have a fair (although incomplete) idea of what a semi-

conductor is and why it can act as it does, and it's time to move on to study the transistor.

How Do Transistors Amplify?

We have just seen how the polarity of voltage applied to a single semiconductor junction between P-type and N-type semiconductor material controls the width of the depletion region which exists at the junction, and so controls the resistance of the junction. This is enough to give us diode action, but something more is necessary in order to get amplification.

Let's sandwich a slice of P-type material between two pieces of N-type material in a single crystal and see what happens. Each N-P junction is immediately surrounded by a depletion region; since we have two N-P junctions, one on each side of the P-type region in the crystal, we have two depletion regions.

Either of these junctions alone will act just as does the single junction of a diode. For instance, if we forward-bias the leftmost junction in Fig. 7 and leave the right-hand junction disconnected, the depletion region becomes narrower. If we apply reverse bias, the depletion region widens.

But since both junctions are in a single crystal structure, something more complicated happens if we apply bias voltages to both. If the thickness of the P-type portion

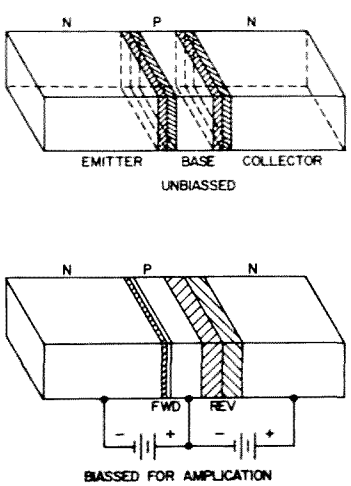
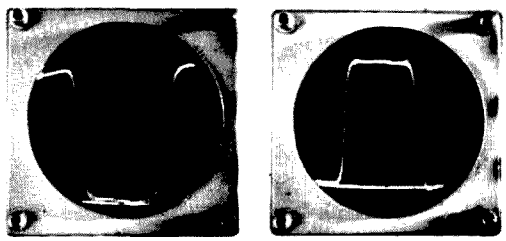


Fig. 7. Placing two junctions in a single crystal structure produces two barriers and two depletion regions, as shown at top. When bias voltage is applied as in bottom view, one junction is forward biased with small depletion region and other is reverse biased with large depletion. This makes amplification possible.

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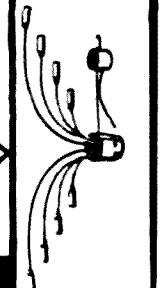
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of the crystal is small enough, and we forward-bias the one of the two N-P junction, many of the electrons which go into the N-type material shoot right on through the P-type region without meeting any holes, picking up enough energy on the way that they shoot right through the barrier of the other junction into the other N-type region. There, they may meet holes—or, if polarities are correct, may flow right on out into an external circuit.

In order for these shot-through electrons to be able to continue into an external circuit, the right-hand N-type material must be connected to a more positive voltage than is the P-type material in the center. This, however, amounts to reverse bias on the right-hand P-N junction.

And as we saw when examining action of a single junction, a reverse-biased junction has extremely high resistance.

The left-hand junction, being forward biased, shows a very low resistance. Yet it is the electrons injected into this low-resistance circuit which shoot through and affect the current flow in the high-resistance reverse-biased circuit. This is a *transfer* of signal from a low-resistance to a high-resistance circuit, with very little loss of current, and such a transfer amounts to a power gain (1 mA in a 10-ohm circuit is 10 microwatts; the same 1 mA in a 10,000-ohm circuit is 10,000 microwatts, or 1000 times more power).

This is, about as precisely as we can put it without resorting to pages of higher math, just how a transistor operates. What we see in **Fig. 7** is an NPN transistor; the N-type material at the left is the emitter, the P-type region in the center the base, and the N-type material at right is the collector.

The names applied to the elements of the transistor may make a little more sense now. The emitter emits electrons, under the influence of the forward bias between itself and the base. Actually, the electrons are pushed out by the battery which establishes the forward bias. They shoot right through the base region into the collector, which collects them.

The amplification comes about because the emitter-base circuit is at low impedance while the base-collector circuit is at high impedance, and the flow of electrons all the way through from emitter to collector is a series circuit in which constant current flows.

Not all the electrons make it through the base region, of course. A few of them must recombine with holes in the base, to maintain a current flow in the base circuit and keep the emitter-base junction forward biased. Almost any transistor, though, will let at least 95 percent of the electrons which leave the emitter reach the collector. High-gain transistors permit only a very small fraction of one percent of the emitted electrons to be trapped by the base.

In the early days, a factor called "alpha" was used to rate the gain of transistors, and it was, specifically, the ratio between the number of electrons reaching the collector and those which left the emitter.

It wasn't measured by counting electrons directly, of course. Instead, current in the emitter circuit and current in the base circuit were measured and compared. An alpha of 0.99 meant that for every 100 mA in emitter circuit, 1 mA flowed in the base circuit and the remaining 99 went on through to the collector circuit. Alpha always ranged between 0 and 1; a very high gain unit might reach 0.9999999999, but it could never quite get to 1.0 because if it did, no current would be left to flow in the base and keep the transfer action going.

Partly because of this bit of mathematical confusion, and more because of a change in the preferred type of circuits as designers gained experience with the transistor, a different rating called "beta" by most and "H_{fe}" by some came into widespread use, and today most gain comparisons are made on the basis of beta rather than alpha.

The beta of a transistor is the ratio between the current flowing in the base circuit and that flowing in the collector circuit. Our preceding example, for instance, with 1 mA in the base and 99 mA in the collector, would result in a beta of 99.

Beta and alpha are mathematically related by the fact that all the current reaching either the base or the collector normally goes through the emitter; if you know alpha and need beta, simply divide the alpha figure by the difference between 1 and alpha (to apply this to our example, 0.99/(1-0.99) or

0.99/0.01) and the result is beta.

Actually, a small amount of leakage current may flow, so that these and other mathematically based relations do not always hold true in practice—but they're usually plenty close enough for our purposes.

The NPN transistor we have just looked at operated with polarities very similar to those of vacuum tubes, except that the base (which corresponds to the grid of the tube) is positive rather than negative with respect to the emitter (which corresponds to the tube's cathode).

Transistors differ from tubes in one major respect, however. Tubes can only employ electrons as their carriers, because holes cannot exist in a vacuum (they are an inherent part of crystal structure and cannot exist outside that structure). Since the transistor uses crystal structure to achieve its effects, it can just as easily sandwich a slab of N-type material as a base between two slices of P-type, and we then have a PNP unit instead of NPN.

The PNP unit operates exactly as does the NPN, except that holes replace the electrons as the charge carriers, and all the bias-voltage polarities must be reversed.

The existence of both NPN and PNP transistors makes many circuits possible which cannot be done with tubes. For example, a single-ended input signal can drive a push-pull amplifier direct without any need for phase inverters or center-tapped driving transformers, if one half of the push-pull stage used an NPN transistor and the other half is PNP (providing that bias is properly set).

When we compared junction diodes and vacuum diodes, we found a number of differences which also apply to a comparison of transistors and triode vacuum tubes. Here are a few more:

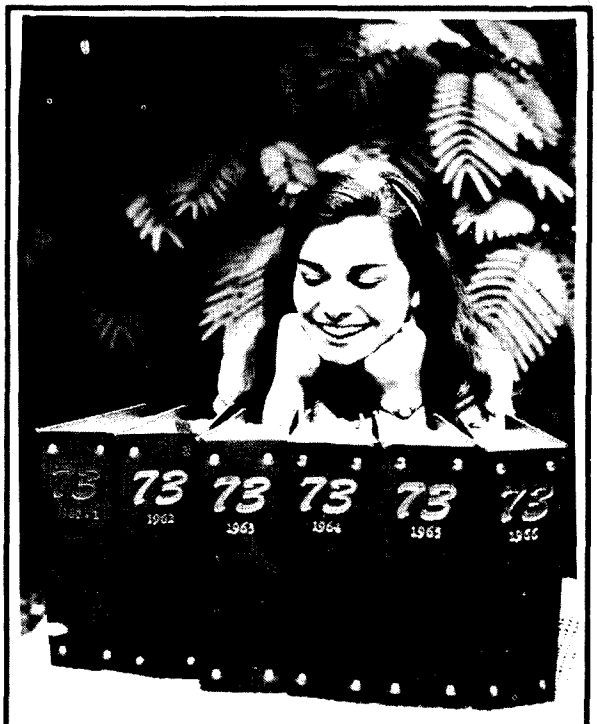
1. The main current flow in a vacuum tube is from cathode to plate; in an NPN transistor, the main current flow is from emitter to collector. In the tube, the current passes through the grid; in the transistor, it passes through the base. Thus the emitter of the transistor corresponds to the cathode of the tube, the base to the grid, and the collector to the plate (Fig. 8).

2. In most applications of tubes, no

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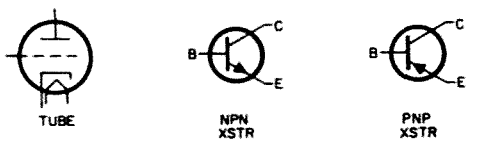


Fig. 8. Schematic symbols for both NPN and PNP transistors as compared with symbol for triode tube. Type of transistor is indicated by direction of arrowhead on emitter lead; the arrowhead points in the direction of positive current flow. Symbol corresponds closely to that for semiconductor diode, in which arrowhead also points in direction of positive current flow (as opposed to negative electron flow).

current flows in the grid-cathode circuit, so that the grid of the tube is a very high impedance. In most transistor applications, the base-emitter junction must be forward-biased and current flows; the circuit is a low impedance. Thus the input resistance of the tube is usually much higher than that of a transistor.

Since the emitter, base, and collector of the transistor do correspond to the cathode, grid, and plate of the triode tube, transistors can be hooked up as amplifiers in circuits (Fig. 9) which correspond to the three types of vacuum-tube amplifiers: conventional grounded-cathode, grounded-grid, and cathode follower.

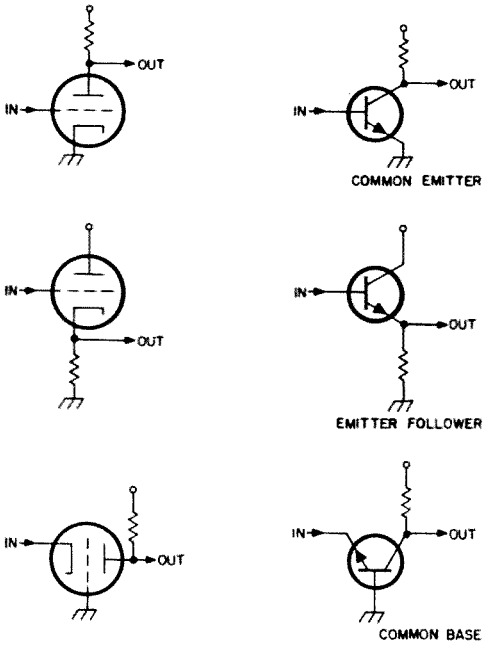


Fig. 9. The three basic types of transistor amplifier circuits are shown here as compared to the corresponding vacuum-tube circuits. Only signal paths are shown; each transistor circuit requires bias arrangements also as shown in Fig. 10 for the common-emitter case.

The corresponding transistor amplifier circuits are known as the common-emitter, common-base, and emitter follower or common-collector. The common-emitter circuit is most frequently employed now, and corresponds to the grounded-cathode tube circuit. The emitter follower or common-collector circuit is frequently used to increase input resistance of transistor circuits.

Characteristics of each of these transistor circuits are roughly similar to those of the corresponding tube circuit, keeping in mind the inherent lower input resistance of transistors.

Like the grounded-cathode tube circuit, the common-emitter transistor amplifier offers moderate input resistance and reverses the phase of the signal between input and output.

The emitter-follower, like the cathode follower, has high input resistance and a voltage gain of less than one. Phase of the output signal is the same as that of the input.

Any transistor circuit, whether common-emitter, common-base, or common-collector, must be biased properly in order to amplify. The bias voltages establish the required reverse bias of the collector-base junction and forward bias of the base-emitter junction. The collector bias voltage corresponds directly to the B+ or plate supply voltage of the vacuum-tube circuit, but the base bias voltage differs from the grid bias of a vacuum tube because current normally is allowed to flow in the transistor's base circuit.

For proper amplification, base bias is somewhat critical—but no more so than is the grid bias of a tube. If too much current is permitted to flow in the base circuit, the transistor will act as a switch rather than an amplifier; if insufficient current flows, the transistor will be cut off (little or no collector current). The overbiased condition is known as "saturation," and the underbiased conditions as "cutoff." For proper amplification in most circuits, bias should be adjusted to a value halfway between cutoff and saturation; this will permit the largest possible input signal swing between these limits.

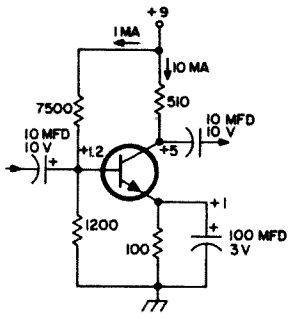


Fig. 10. Emitter bias circuit as applied to a common-emitter audio amplifier circuit using an NPN transistor. Emitter resistor's value is chosen to give a convenient amount of voltage drop when desired emitter current flows, and voltage divider supplying bias to base is then set to provide this same voltage plus barrier offset (about 0.2 volt for germanium transistors or 0.6 volt for silicon). Emitter current will stabilize at desired value. Change in supply voltage requires only changing of base voltage divider to keep base voltage constant.

In a vacuum tube, amplification can be controlled by varying the grid bias. Changing the base bias of a transistor has much less effect upon the amplification, although a limited control is possible by this means.

Bias can be supplied from separate supplies, but it's more common to use a resistive voltage divider to put the base at some voltage between the collector-supply level and ground, and include a moderately small resistor in the emitter circuit as shown in **Fig. 10**. This corresponds to the "cathode bias" arrangement used frequently in tube circuits; it makes the bias automatically self-compensating to just that amount which will permit a desired level of emitter current to flow. While **Fig. 10** show this in a common-emitter circuit, the same bias arrangement can be used for any of the three types of circuits by moving the ac grounds and signal input/output points while leaving the dc portions of the circuit unchanged.

What Factors Affect a Transistor's Amplification?

Now that we've met the transistor as an amplifier, it's time to take a deeper look at the factors which affect the transistor's performance in this role.

Among these factors are the signal frequency, the construction of the transistor, the circuit constants, and many others. Let's look at the transistor's construction first, because in practice we have no control over this except to choose a particular type of transistor which has the type of construction we desire.

The transistor which we used as an example (**Fig. 7**) was a single crystal of semiconductor material with the base sandwiched between the emitter and collector. We drew it in the shape of a long narrow slab to make the explanation easier to follow visually—but very few actual transistors use this shape. In practice, the designer of a transistor must juggle such factors as the width of the base region, the capacitance across each junction, the thickness and volume of the collector (which sets the power rating of the unit), and the area of the emitter junction. Most of today's common transistors, as a result, resemble tiny ham sandwiches; they are spread out over a wide area but are not very thick. The collector is the largest part, with the base on top of that and the emitter covering the base; both emitter and base are normally very thin.

The width of the base sets a limit on signal frequency, because any carriers which remain in the base region for an appreciable fraction of a signal cycle cannot be controlled by the signal (it will be pulling them part of the time and pushing them the rest of the time). Early transistors were limited to audio frequencies because of this, but modern units are capable of amplifying well into the rf range and many "ordinary" transistors operate nicely up to 5 or 10 mhz. For higher frequencies, different construction techniques are used; transistors which operate in the ghz frequency range are available although expensive.

Base width also determines to some degree the amplification ability of the transistor; a thick base can capture more carriers than can a thin one, which means that fewer carriers will go on through to the collector. This increases the base-current/collector current ratio, which reduces both alpha and beta.

Circuit constants affect transistor amplification in the same manner as they affect tube amplification; a high value of load resistor will give increased voltage gain, if

enough current can be made to flow through it. Increased forward bias will permit greater current flow. However, each type of transistor has an optimum operating point which provides maximum amplification consistent with linearity. You can get higher gain, but at the cost of possible distortion.

Is Amplification All?

The most familiar use of transistors, to most of us, is in amplifiers or amplifier-related circuits such as oscillators or active filters. However, as we've already glimpsed, the transistor also has the capability of acting as a switch if the base bias is varied between saturation and cutoff—and in fact, the most common use of transistors today is not in amplifiers at all, but as the switching element in digital computers.

A switching transistor and an amplifier transistor are essentially the same, except that the switching unit is designed to emphasize its switching properties and is not tested for use as an amplifier. Despite this, most switching transistors make highly acceptable amplifiers if you're willing to develop your own circuit constants for them.

When a transistor is saturated, that is, when so much base current is supplied that no additional change of collector-emitter resistance can occur, it is a better switch than many mechanical switches. The voltage drop from collector to emitter under these conditions is usually much less than 0.1 volt (as compared to the 0.25-volt drop between base and emitter at the same time).

In cutoff, however, almost no current flows through a silicon transistor, and very little through a good germanium unit.

By removing the base-bias network from a common-emitter amplifier circuit and bringing the base lead out (through a current-limiting resistor) as the input terminal, we have the basic transistor switching circuit shown in **Fig. 11**. If voltage is applied to the input with a polarity that provides forward bias to the base-emitter junction, current can flow in the load circuit. In the absence of input voltage, or with reverse-bias polarity, current flow in the load circuit stops.

Placing a resistor in the load circuit, and then connecting two such switching circuits back to back as in **Fig. 12**, gives us a

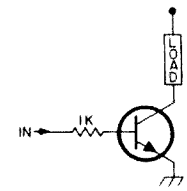


Fig. 11. Basic transistor switch circuit is simplicity itself. Transistor is connected in series with the load to be switched, and control voltage is applied through a resistor to the base, to assure cutoff in the absence of control voltage input, but in many cases the zero-bias leakage current is small enough that no more components than shown here are necessary.

"memory" circuit. If we ground terminal 1, this will cut off transistor Q1 and halt the flow of current through R1. With no current flowing through R1, the collector of Q1 will rise toward the supply-voltage level. This provides forward bias to Q2, driving it toward saturation and permitting current flow through R2. When Q2 saturates, the voltage at its collector is virtually ground level and we can now remove the ground from terminal 1 because Q2 has turned into a permanent ground at the same point in the circuit.

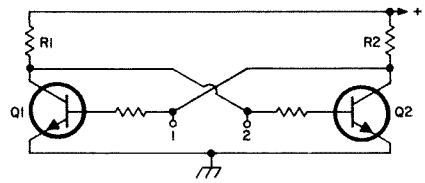


Fig. 12. Two simple transistor switches (Fig. 11) with resistors for loads, and cross-coupled to each other back to back, form a simple memory circuit which is actually used in some digital computer designs, and which is the heart of most of the more complicated flip-flop circuits. This version is known to computer designers as the "DTL flip-flop" (direct transistor logic). Operation is explained in the text.

This circuit will "remember" that condition until we ground terminal 2, no matter how long we wait. When we ground terminal 2, we remove the voltage from the base of Q2 and thus cut it off. The voltage at Q2's collector rises, driving Q1 into saturation. When Q1 saturates, it holds Q2 cut off. The circuit is now remembering a new condition.

This circuit, called a "flip-flop" by most computermen in this country and known to engineers as a bistable multivibrator, is the heart of most computers. In practice, more elements are needed in order to speed up

action, etc.—but the simple sample circuit here will work as described.

While the transistor's use as a switch is its most common application, and its use as an amplifier is the most familiar to most of us, there are still other uses.

One of the more interesting is its use as a current-controlled resistor.

Both amplification and switching action in the transistor come about, as we have seen, by a change in the resistance of the collector-to-emitter circuit caused by a change in the current flow in the base-emitter circuit. We can, then, simply use the collector-to-emitter circuit as a variable resistor, and change its resistance by changing the current flow in the base circuit.

This offers, as one example, a simple automatic gain control technique. The agc control voltage is converted to current by a series resistance and applied to the base of a transistor; the transistor is in series with a fixed resistor which forms a voltage divider for the signal being controlled.

If control voltage and consequent base current are high, the transistor's resistance is low and the voltage divider has low output. If control voltage and base current are low, the transistor's resistance is high and the voltage divider has little effect.

The circuit, diagrammed in **Fig. 13**, can be applied to many other uses. It has been used, for instance, as a motor speed control—but in such a use the transistor must

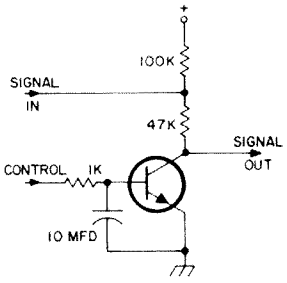
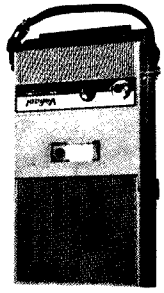


Fig. 13. Transistor may be used as current-controlled variable resistor to provide AGC circuit as shown here. Application of positive control current or voltage reduces collector-emitter resistance of transistor, reducing output voltage. Reduction of control current increases transistor resistance, raising output voltage. Topmost resistor is to isolate signal from low impedance of power supply. Values are only suggested; in any specific application they would have to be tailored to the needs of the circuit.

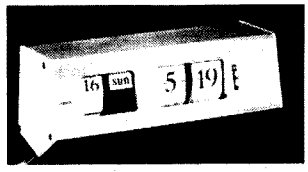
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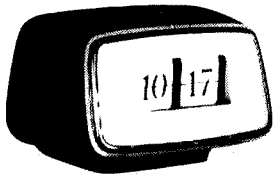


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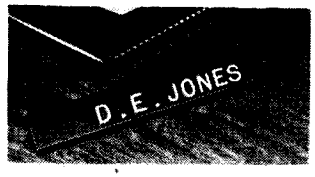
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dissipate large amounts of power (in the agc application, almost no power is involved).

What About the Rest of the Family?

We've examined junction diodes and junction transistors, both silicon and germanium types. We have by no means seen all the semiconductor family. We have completely skipped over the point-contact diodes and transistors, partially because they are little used today but primarily because modern theory indicates that they are actually junction devices in which the junctions are created at the points of contact during use (which means that they operate in essentially the same manner).

Some of the other semiconductor devices operate in totally different fashion although based on the same basic events in a crystal structure, and some bear the same relation to transistors that transistors bear to diodes—an apparent combination, modified by the fact that the whole combination is in a single crystal.

The silicon controlled rectifier (SCR) is one of these combination devices. It can be simulated by a hookup of PNP and NPN transistors as shown in Fig. 14—but only if both transistors have essentially zero leakage current. It is a switching device only; when "off," almost no current flows through, and when triggered "on" by a small signal in the gate circuit, a large flow of current can flow with no more voltage drop than an ordinary silicon diode.

Fig. 14 indicates that such a device should be able to be turned either "on" or "off" by control signals; most SCR's only turn "on" by control signals, and must be turned "off" by other means. A similar device based on the same principles, known as the silicon controlled switch (SCS), has both "on" and "off" capabilities.

The four-layer diode is similar in characteristics to the SCR but has only two terminals; the "turn-on" signal is generated inside the crystal structure by the applied voltage. The result is that the device is an open circuit for voltages below a critical "threshold" value, and a closed circuit for voltages above that value.

The unijunction transistor, originally called the double-base diode, is a completely different device. It has only one junction, and injection of current into this junction affects the current flow through the main mass of semiconductor material. This device does not amplify, but is excellent as a switch in timing circuits similar to neon-bulb oscillators.

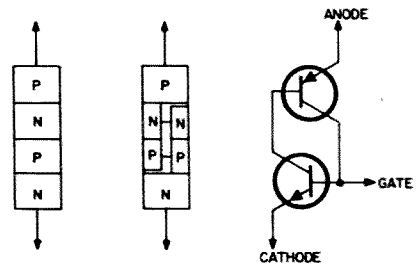


Fig. 14. Actual structure of SCR is four-layer PNPN sandwich as shown at left, but operation is very similar to that of two perfect transistors as shown in center, hooked up as shown in schematic at right. If both transistors have almost zero leakage, circuit at right will work; in SCR, leakage is held to minimum by action within the crystal structure.

The field-effect transistor is something of a cross between the ordinary transistor and the unijunction. Fig. 15 shows how it works in principle. Only one junction is involved, and it is always reverse-biased. The amount of reverse bias varies the depth of the depletion region in the main mass of the material, which varies the resistance between the source and drain terminals. The FET has operating characteristics very similar to those of a vacuum tube—input resistance is high and no current flows in the input circuit.

Voltage-variable capacitors and varactors are simply specially processed junction diodes, making use of the variation of the depletion region thickness with variation in

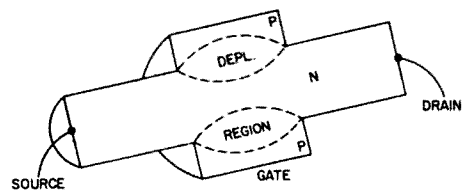


Fig. 15. Cutaway view of theoretical field-effect transistor shows how depletion region created by reverse bias of the gate material (in this example, a ring junction all the way around the main semiconductor) "pinches" down the available current path and so increases the device's source-drain resistance. Actual FET's are considerably more complex than this simple model.

bias voltage to change capacitance across the junction.

Zener diodes and tunnel diodes are also specially processed junction diodes. A zener diode is built to maintain a constant breakdown voltage in the reverse-bias direction and serves the same function as a vr tube. A tunnel diode contains much higher levels of impurities and apparently operates in precisely zero time (the physics of it are still somewhat unclear to most students); the effective result is the establishment of theoretically impossible negative resistance, which in turn makes any resonant circuit capable of oscillation.

The "integrated circuit" is today's frontier of semiconductor study; any one integrated circuit contains transistors, diodes, resistors, capacitors, and conductors, all of which may be grown into a single crystal structure. When each individual component of an IC is examined by itself, it is found to be identical to that same component in any other application—the IC is more a means of packaging complete circuits in very small spaces than it is a separate member of the semiconductor family.

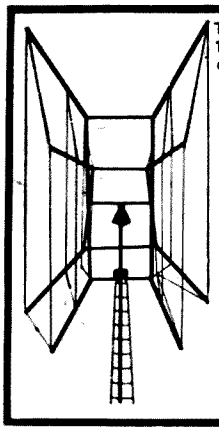
This is not all the list by any means; semiconductor technology is moving so rapidly today that no list could ever be complete, because new types would be invented in the time between writing the list and its publication. However, these are most of the members of the family that you're likely to meet soon in the radio world—and this is enough of their basic theory to provide answers to all the semiconductor questions on the Extra Class examination.

. . . Staff

More Wax

Besides emergency fluxes and lubricants, wax can be used to set those set-and-forget controls, like the regeneration pots on the Heath Lunchboxes, and bias settings. Hold the candle (lit!) half an inch over the control and let wax drip into and around it for about half an inch around it. You can also tell if someone has been tampering with the rig.

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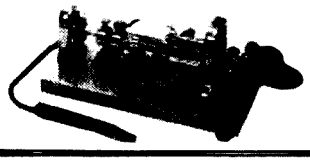
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A Preamplifier for the CB and Ten-Meter Bands

Mark Gutekunst WA3HMW
27 Rorer Avenue
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Did you ever want to listen in on the CB or 10 meter bands and find your receiver sounded completely dead? Perhaps it is too noisy and the signals are there but you cannot hear them, or maybe it simply is not sensitive enough.

What you need is a high-frequency preamplifier, and a nice surplus item can be converted very easily to boost your receiver's performance.

The Conversion

Begin with a No. MFP-50 10 meter preamplifier. This comes unconverted at around $5 plus postage.

The conversion consists of installing two BNC connectors and appropriate power connections; adding a link input circuit, and tuning up. You may need to build a power supply. Here is the conversion process:

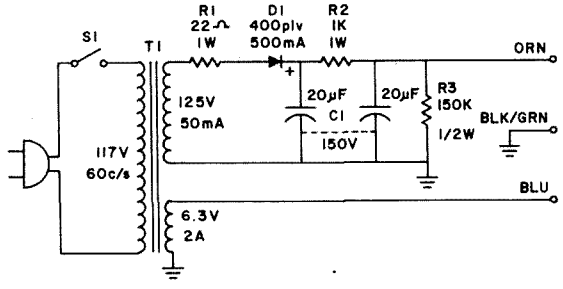


Fig. 1. Power supply circuit. Parts list: C1-dual—20μf, 150 volt electrolytic; D1—400 piv 500 ma silicon rectifier; R1—22ohm 1 watt resistor; R2—1000ohm 1 watt resistor; R3—150K ½watt resistor; S1—SPST toggle switch; T1—Power transformer, Allied 54C 1411, primer 117 volts ac, secondary 125 volts ac, 50ma, 6.3 volts ac 2 amps.

Step 1. Remove connector from 6 inch cable and add extension cable or other provision for connections to power supply. Connections are: Black, chassis ground. Blue, 6.3 volts at 0.45 amps heater ac. Orange, 120 volts dc screen and anode supply, about 30 ma. Green, chassis ground. Brown, not used.

Step 2. Replace black bakelite plug under the chassis with a BNC connector, and label this "Input." Remove coil form L1301.

Step 3. Wind 6-8 turns of No. 20 enameled wire around coil T1302, grounding one end and connecting the other to the BNC connector previously installed.

Step 4. Replace connector J1301 with a BNC connector, and label this "Output."

Step 5. Remove the two pi-wound chokes, one at each end of the chassis along with the red wire that connects the two chokes.

Step 6. Complete the power connections and install the preamplifier in your receiver's antenna circuit. Turn it on, let it warm up, and then peak TI301 and TI302 in the center of the 10 meter band. You may need to use solvent to soften the cement holding the slugs in place, or you will chew up the slot on the coil slug.

Results

This preamplifier should make any surplus or cheap ham receiver come alive on 10 meters. It is quite broadbanded, shows a possible 30 dB gain, and has a very low noise figure. Any questions will be answered if an S.A.S.E. is enclosed. Gud Luck!

. . . WA3HMW

Proper Use of Silicon Rectifier Diodes

R. T. Brackman WA3ACL
Physics Dept.
University of Pittsburg
and
M. Weinschenker K3DPJ
Box 353
Irwin PA

One or two of these tiny components, closely resembling resistors, can do the same job as a large vacuum tube of not too many years ago. They cost less than the tubes, and are more effective. But if abused they can depreciate to zero value in part of a millisecond. What are they?

They are silicon diodes, available on the commercial or surplus markets at very economical prices. Their basic electrical property is very simple: in the forward direction they will pass up to several amperes (for a small silicon diode) at a constant voltage drop under 1 volt. And in the reverse direction they will pass a tiny current. The details of these properties are different for various types and for individual specimens of a given type of diode. Rectifier diode failures in practical applications are directly associated with these two properties of forward conduction and reverse resistance.

The Forward Current Rating

When a diode is in forward conduction, which normally is during the part of each half-cycle when the voltage applied to the diode exceeds the voltage appearing across the filter input terminals, the combined voltage across the diode and the current through it indicate a certain amount of heat energy is released in the diode. In normal operation the diode gets warm.

If the current becomes large enough, the diode may be heated to a point at which it is either unable to resist the reverse voltage appearing during nonconducting parts of its operating cycle, or to a point at which the semiconductor doping atoms begin to migrate to new sites. Either condition is likely to prove fatal, since a breakdown condition or doping atom migration increases diode temperature and resistance.

Once the failure process starts, it develops regeneratively to a catastrophic end. This is why manufacturers are very specific about forward surge and inverse specifications. A key point in forward rating specs is that the diode does have a certain internal resistance, and heat dissipated in this resistance increases as the square of the current. Surges, such as tend to occur when turning on a capacitor-input supply, immediately after an accidental short, or during sideband or photoflash operation, may destroy diodes. See Fig. 1. If your power supply consumes diodes at an unreasonable rate, this possibility deserves investigation.

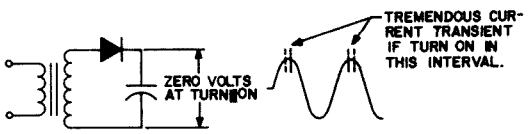


Fig. 1. If a power supply is turned on at the instant the supply voltage is at its peak, the transformer sees a short-circuit and may be required to deliver tremendous amperages through the rectifier diode circuit.

PIV Rating

When a diode fails, the typical conclusion is that its PIV has been exceeded. This conclusion *may* be correct. If the diode's forward current ratings have been given due respect, the possibility of inadequate PIV rating becomes quite likely.

There is an instant during each operating cycle when, if there is any kind of filter, the filter voltage and the applied ac voltage combine to apply a maximum reverse-

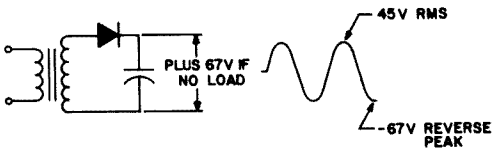


Fig. 2. There is an instant during each cycle in normal supply operation when the diode is facing into full capacitor voltage, with the transformer in back of it exerting an opposite voltage. This is the instant when diode failure from PIV stress is most likely.

voltage stress to the diode. See Fig. 2. If the diode is unable to resist the stress it goes into conduction. This is not necessarily fatal, and zeners normally operate in a breakdown mode.

But since there is plenty of power available from the transformer and stored in the filter, a large reverse current flows. The diode becomes very hot, doping atoms migrate, and the junction loses its rectifying properties. It conducts about as well as a piece of wire in either direction. It has failed.

Manufacturer's PIV ratings tend to be realistic, and the ratings of surplus diodes may be optimistic. That is, these ratings are exceeded only with expectations the diode may fail any cycle now – and at 60 hz the failure is generally not very far off.

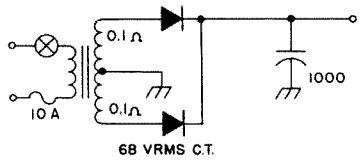


Fig. 3. Real transformers typically have low secondary resistances, if they are high-current transformers, or designed to deliver large amounts of power. This simple circuit will generate current surges on turn on in the hundreds-of-amperes range.

Practical Applications

In Fig 3. is shown a simple power supply for 48V with a large filter capacitor. After several days of operation, it fails. Why is this?

Looking at the schematic, perhaps you think of forward-current overload. This possibility deserves attention, since nothing in the schematic seems provided to limit the forward current upon turn-on, and the fuse is very large. But could the forward current ever be disastrously high?

Suppose the supply is turned on just at the instant the transformer secondary voltage swing is at its peak. At this time the emf is around 75 volts, and it will feed into an empty filter capacitor. This is a short, for practical purposes.

Circuit resistance being around 0.1 ohm here, a surge current of 750 *amperes* might be expected. That's why the primary fuse is so large! A scope test would show real surges of only a few hundreds of amps since the real transformer probably cannot deliver really heavy surges. But it *can* blow 1-amp fuses, and that's what the schematic specifies.

One answer to this problem is a series surge resistor, which is shorted during normal circuit operation. A 1-ohm resistor pares these surges down to 75 amps maximum, and if regulation is not too important, the shorting provision may be omitted. Another answer is a thermistor, which offers a relatively high cold resistance, but as it becomes warm its resistance drops to a low value.

Now let's examine the string of diodes appearing in Fig. 4. These diodes are healthy and the supply has been turned on without any harm because you have carefully provided a primary resistor to limit the turn-on current surge. When the voltage across the filter capacitors reaches about two-thirds of full value, a relay shorts the limiting resistor for normal operation. Now, having finished your work, you turn off the supply.

But you notice it makes a rather heavy "thunk!" Feeling suspicious, you turn it back on again, and within seconds the limiting resistor is emitting clouds of smoke. The fuse blows. What went wrong?

Looking at Fig. 4, we observe the diodes do not all have the same PIV ratings. Here we have the measured, not the advertised, breakdown voltages. At the moment we turned off the supply, the turn-off transient overvolted the string, and pushed the other string into conduction. Otherwise it would have been a much larger transient, suggesting to us that half-wave rectifier diode strings must be more conservatively designed than full-wave systems.

When the string was overvolted, one or two of its diodes went into reverse conduction, increasing the stress on the remaining diodes. They collapsed like a row of dominoes. The initial breakdown was followed by a powerful reverse current surge as the filter capacitor discharged back through the transformer, producing that "thunk" you noticed. Possibly the surge overvolted the other diode string, and that failed too.

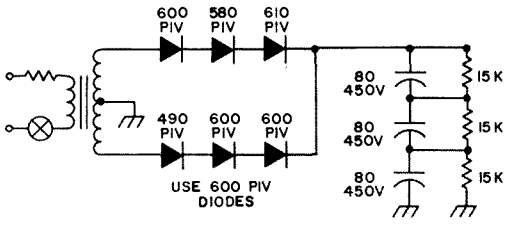
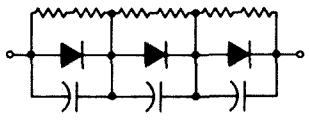


Fig. 4. This circuit may not show very good diode life. Diode PIV s shown are measured; the nominal specification is given in the corner of the drawing, and would be used in ordering diodes.

To avoid this accident, replace the original string with a more conservative arrangement as shown in Fig.5. The sum of all the PIVs might be twice the estimated maximum inverse voltage the circuit can generate, and a factor of 2.5 is good practice.



RESISTORS 47K 1W
CAPACITORS .005 M 1KV
DIODES 800 PIV

NOTE: 1W RESISTORS ARE RELIABLE AT 300V, USE TWO IN SERIES.

Fig. 5. Revised diode string for improved reliability. The PIV spec has been increased from 600 to 800 volts, and an RC network added to equalize DC and transient voltage stress along the string. Note the network must be connected to every junction between diodes, not just at the ends.

Further good practice is to place resistors and capacitors in parallel with the diodes. The resistors act as a divider to equalize voltage stress along the string for dc and low-frequency ac voltages. The capacitors do the job for the high-frequency transients. This string is now quite dependable.

Full wave CT choke input .....No derating necessary
Full wave CT capacitor input .....Use only 70% of the current rating
Full wave bridge capacitor input ...Use only 50% of the current rating
Full wave bridge choke input .....Use only 70% of the current rating
Full wave doubler circuit .....Use only 20% of the current rating
Simple half wave circuit .....Use only 40% of the current rating

Fig. 6. List giving the approximate current deratings for various types of power supplies.

Other Suggestions for Supply Design

Manufacturers' transformer current ratings are sometimes rather optimistic, or rely upon test conditions not known to you. For a specific application, good practice is to make up a breadboard circuit that will load the transformer in the same way as normal operation in the proposed circuit. That is, if 100 ma load is expected, and a 1000 uf filter capacitor, this is quite different from a resistive load. Making up a complete rectifier circuit, you can check out the resulting system and see how hot the transformer actually becomes. See Fig.6 for suggested derating of transformers in various power supply applications.

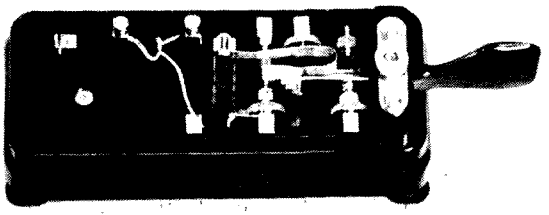
... K3DPJ ■ and WA3ACL ■

First Class Keyer Key

Having built several of the push-em and squeeze-em gadgets used to key todays automatic keyers, I was in doubt as to whether keys made with magnets, polar relays, brass stock and hinges were really worth all the effort. After all of my experimenting I came back to where I probably should have started in the first place. I modified my original bug.

My bug happened to be a Lafayette 99-2552, which sells for $10.95, but it is no different from any other bug. I like it because it has plenty of lead in its belly and rubber suction cups to grab the table.

Here is what I did. First I cut off the vibrating spring and weight end piece with electricians shears. This definitely commits you to the change. Tin snips won't fit down into the space to get at the spring. The two wire original cord was replaced by a three wire lead. The back original terminal is connected to the key lever arm underneath and this connects to the keyer ground. The dash terminal is the forward terminal. Run the third lead over to the left side of the key and fasten under the knurled nut used to adjust the stop. This is now the dot contact and the old dot contact is not used. Check out the key leads with an ohmmeter if there is any question.

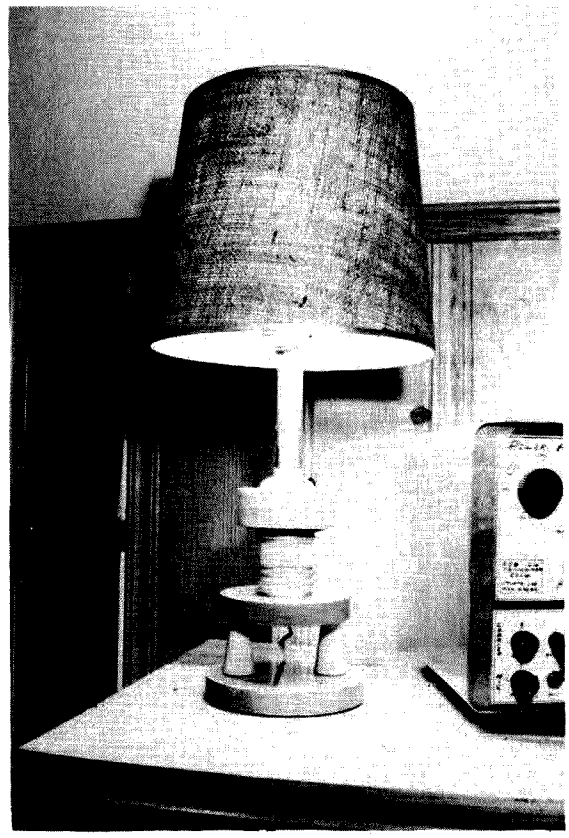


This key has the advantage of feeling like the old bug, but after a few weeks practice with the automatic key you'll never go back to the old bug again. It does take a while to break the old sending habits, but after you hear the dots coming out so much cleaner than those scratchy old bug dots you will never regret the effort spent in learning the new technique.

... Ed Marriner W6BLZ ■

W. F. Stortz K3QKO
5122 Alberta Ave.
Baltimore, MD 21236

Converting the 4CX1000A into Lamp



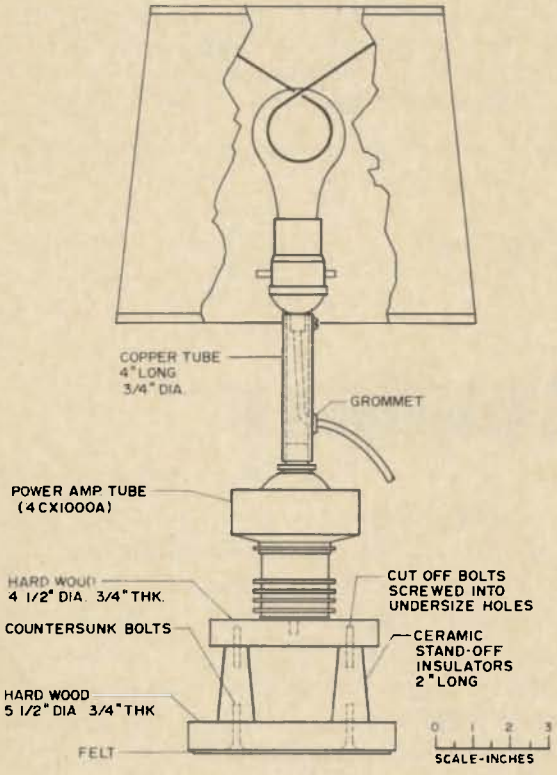
The finished lamp is a real conversation piece.

The average well-read ham knows exactly how to put to effective use his old TV set, burned out transistors, and half shot surplus diodes, but what to do with that $20 to $150 gassy final power amplifier tube presents a problem that almost defies even the most clever homebrewer. You can not just toss such an old friend into the trash can. Besides, who knows, wishful thinkers might expect it to start working again, after a well-deserved rest. Well, instead of storing it in some out of the way place until it's forgotten, here is a way to keep it intact and useful at the same time. Make a lamp out of it. Don't let out with the, "Oh boy, that caps everything" until you read a little farther. This project is very easy and I cannot think of another one more likely to go on without trouble. It will transform the XYL back into the loving wife when she finds that you must depend upon her shopping skill to select a lamp shade that matches the decor of the ham shack.

Construction

Glancing at the drawing (**Fig. 1**) you can see how a 4CX1000A was transformed into a really unusual conversation piece. This method can be used for any tube with a plate cap. The only changes that will have to be made are in the diameter of the copper tube post and the mounting holes in the base. All the connections to the power tube are press fit so as not to damage it. I could not get up courage enough to drill into such a magnificent dud; besides, the appearance of the lamp is enhanced with the tube showing signs of being in mint condition. The wood discs in this case were made of maple but only because there were two small pieces available. Any hard wood will do but it must be finished to as neat a polish as possible in order to provide the proper setting for the tube. After shaping and drilling, the bases should be sanded to remove all scratches with 200 grit garnet paper. Staining them to the color indicated by the wife is accomplished with ease using a Kleenex to wipe it on. The final finish is a coat of clear plastic spray that can be picked up at the variety store when you buy your socket and wire. The copper tube post likely will not fit the plate cap. In the case of the 4CX1000A the tube had to be expanded a little by driving a greased socket from a wrench set into it and then doing a bit of

Fig. 1. Diagram of lamp construction.



scraping with a penknife. In other cases it might require some type of filler, but select a tube of a diameter where the least amount of modification is required. A great deal of strength of connection will not be necessary. The socket can be mounted as shown in Fig. 1 or a complete lamp socket kit can be obtained from the variety store that contains many cork bushings that can be used to adjust the diameter of the socket mount so it will fit almost any size tube. After completion, the copper post is polished with steel wool and along with the other metal parts is sprayed with clear plastic to prevent tarnish.

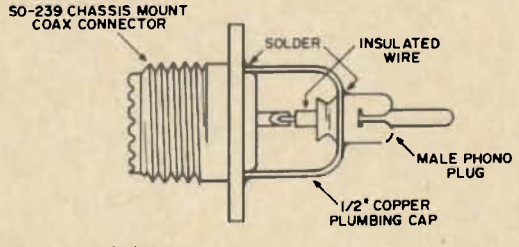
The effort of converting your defective power amplifier tube cannot in any way be in vain. If your wife returns to the XYL role and orders the thing out of the house because there is no place to plant Philodendron in it, pen your call in some prominent place and give it to a deserving chap to take to college with him. There certainly will not be a more "Now" lamp at the school and you will enjoy the bravos of the artistic world with Michaelangelo and Salvador Dali.

. . . K3QKO

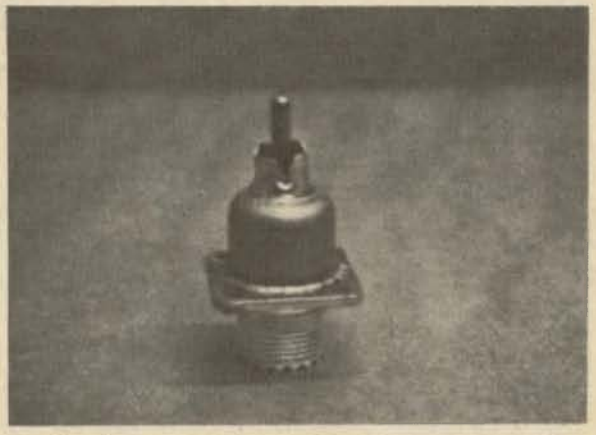
Coax to Phono Plug Adapter

Several pieces of ham gear, notably Heathkits, use a phono connector for the antenna terminal. While these work well, most ham stations are set up to use coaxial terminations, and adaptors for this type of plug are not readily available.

An inexpensive adapter can be made using an SO-239 coax fitting, a phono plug and a ½" diameter copper plumbing cap. The results are a structurally rugged adapter with electrical properties considerably superior to the usual "plug dangling at the end of the connector" type that are so common!



Drill a 3/8" hole in the copper end cap and solder the phono plug in place. Snip off about 1/8" of the coax terminal, to prevent it from shorting to the phono plug when the unit is assembled. Solder a 3" length of insulated wire to the terminal, and pass it through the phono plug. Solder the copper cap to the coax fitting, then solder the wire to the phono plug. Check with an ohmmeter to make sure there are no shorts between the center conductor and the outside of either fitting.



Originally, I intended to file away the flange around the coax fitting, but later found it to be an advantage as it provides a firm finger gripping surface when attaching and detaching the adapter.

The total cost of the adapter, using all new components, came to sixty cents.

Bud Michaels, WB2WYO

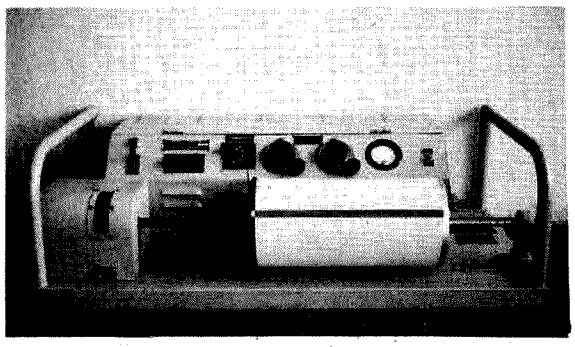
The death of Ralph L. Steinberg in September was a loss to 73 and its readers. His articles have always been of unusual interest, and all of us extend our sympathy to his wife, Lillian.

Facsimile and the Radio Amateur

Ralph Steinberg K6GKX

In the December 1968 issue of *73*, this author made mention of several pieces of facsimile equipment which were used in the summer of 1968 to transmit pictures to the Antarctic. Since then many requests have been received to give more details about the equipment and operations.

To get better acquainted with facsimile, this review will cover some of the mechanical and electronic operations of the TXC-1B facsimile transceiver, MD-168/UX modulator, RD-92/UX recorder and the CV-1066A (CV-172A/U) receiving converter. These are necessary for receiving and transmitting at any facsimile station.



TXC-1B Facsimile Transceiver

This transceiver is quite versatile and can receive photos, sketches, maps or any printed matter either by electro-mechanical optical or stylus needle operation and also record photographs in either negative or positive form. For transmitting, it will handle four 5 x 7 or two 8 x 10 inch photographs in one operation. Color pictures may be transmitted but all reproduction is in black, white or shades of gray.

Three operations are required in transmitting and recording. These are scanning, transmitting,and recording. (See **Fig. 1**) The scanning operation is that of dividing the picture into a large number of elemental segments and this process is accomplished in the facsimile transmitter by a scanning drum and photocell arrangement.

The picture to be transmitted is mounted on a cylindrical drum, which revolves at a revolution speed of once per second and travels along a lead screw (96 threads per inch) at the rate of 12.5 inches in 20 minutes. Light from the exciter lamp illuminates a small segment of the moving picture and is reflected by the picture through an aperture to a photocell. The amount of light reflected back to the photocell is a measure of the light and dark segments of the picture being scanned. During the transmission of a

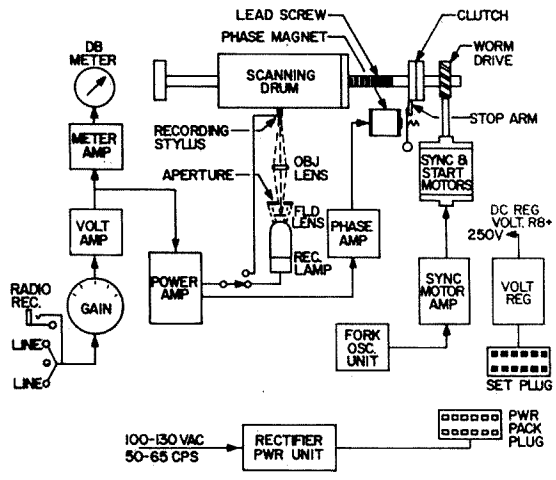


Fig. 1. Receiving block diagram, facsimile transceiver TT-1/TXC-1.

complete picture, this light traverses every portion of the picture as the drum slowly winds around past the fixed lighted area. The reflected beam of light into the photocell, creates voltage variations into the output circuit and establishes the picture signal.

Signals being received by the facsimile transceiver are amplified and serve to activate a recording mechanism that makes a permanent record on the sensitive recording paper and at the same time synchronizes the transceiver drum until the complete picture is reproduced. Synchronization is obtained by driving both the receiving and the transmitting drums with synchronous motors operating at exactly the same speed. The drums can be operated at 30,60,or 120 rpm. The older type models are usually operated at 60 rpm but the newer models operate mostly at 120 rpm.

Framing (positioning) the receiving drum with respect to the transmitter drum, at a distant station, is done by transmitting a series of phasing pulses just before a picture transmission is to begin. The pulses operate a clutch mechanism that starts the scanning drum in the transceiver so that it is properly phased with respect to the starting position of the scanning drum in the transmitter.

A start motor mechanically coupled to the synchronous motor serves to increase the synchronous motor speed above synchronism during the starting period after which it coasts down to synchronous speed when operating on 1800 hz power.

The facsimile signal from the radio receiver is attenuated at the gain control of the facsimile transceiver and then amplified in the voltage and power amplifiers. The power amplifier output drives either the photographic recording or the recording stylus for direct recording. Another circuit from the power amplifier transmits phasing pulses to the phase amplifier, which operates the phase magnet and clutch during the phasing process just before each picture transmission.

The fork oscillator unit develops an output voltage that is applied across the bridge modulator. The frequency of this voltage is 1800 hz. When the bridge is balanced (photocell dark), the output voltage is zero. When the amount of light falling on the photocell varies, the resistance of the cell varies. This action unbalances the bridge and produces an output voltage that varies in amplitude with the variations in light. Thus, the 1800 hz voltage is amplitude modulated in the bridge modulator.

MD-168/UX Modulator

This modulator is designed to convert amplitude modulated facsimile signals from the TXC-1B transceiver to frequency modulated signals.

The input signal to the modulator has a frequency of 1800 hz and an amplitude that varies with the light and dark segments being scanned at the facsimile transmitter. The output signal from the modulator is an audio signal in which 1500 hz represents the maximum signal (in amplitude) and 2300 hz represents the minimum signal input to the modulator from the facsimile transmitter. Amplitudes between maximum and minimum signals are changed to corresponding frequencies between 1500 and 2300 hz. Since the audio frequency shift signal from the modulator is of constant amplitude, the emitted radio frequency carrier is modulated at a constant percentage of modulation.

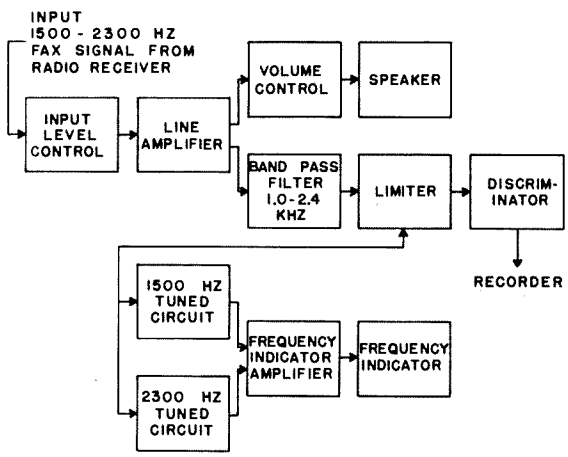


Fig. 2. Block diagram of CU-172A Converter.

CV-1066A (CV-172A/U Converter)

This converter is used to convert the 1500 to 2300 hz facsimile signals received from a radio receiver to AM signals suitable for operating the facsimile recorders like the RD-92A/UX or the TXC-1B facsimile transceiver.

The facsimile signal from the radio receiver is fed through an amplifier and filter

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☐ 2N3568	5 for $1
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☐ 2N3641-3	5 for $1
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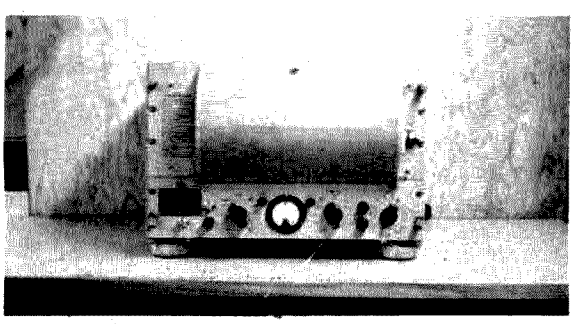
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to a limiter and then through a frequency discriminator. The discriminator is a low-pass filter having a cutoff frequency of 1500 hz. The output of the filter at 2300 hz can be adjusted to be from 10 to 20 db lower than the output at 1500 hz. The input signal is then changed from audio frequency shift signal of substantially constant amplitude to an output signal of varing amplitude in which the maximum amplitude is 10 to 100 times the minimum amplitude. See **Fig. 2.**



RD-92A/UX Facsimile Recorder

The RD-92A/UX recorder will make copies of recordings transmitted by the TXC-1B facsimile transceiver or equipment having the same transmission facilities. See photo. It has some similarity to the TXC-1B transceiver in that both are able to use the stylus needle for recording. Recording by the RD-92A/UX is done by rotating a drum at constant speed, while feeding a stylus needle along the drum, one scanning line for each revolution until the complete drum has been covered.

An amplifier-detector unit receives the input facsimile signal. This signal, consisting of phasing pulses and facsimile information (messages, drawings, maps, etc.) between the frequency limits of 900 and 2700 hz, is amplified by a class A amplifier and demodulated through the action of a full wave rectifier and low-pass filter to form a varying dc facsimile signal. The varying dc facsimile signal output of the amplifier-detector is coupled to the amplifier modulator where it combines with a 15 hz oscillator in the modulator stage.

The signal from the amplifier modulator is amplified by the print driver and amplifier to sufficient intensity, so that, when connected to the stylus needle in the recording mechanism assembly, it will record on the

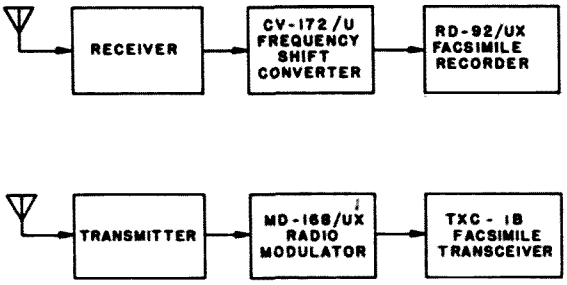


Fig. 3. Block diagram of the transmitting and receiving facsimile equipment.

recording paper points representing varying shades of dark elements of the transmitted copy.

The RD-92A/UX recorder is used aboard ships to receive weather maps and information. It can copy recordings 12 x 18 x 3/4 inches. The input impedance is 1600 ohms and the drum speed is at 60 rpm.

Applications

For amateur radio facsimile operations, the TXC-1B facsimile transceiver can be used on any of the vhf, uhf or microwave bands using either AM or FM modulation. If AM modulation is used, all that is necessary is to plug the facsimile transceiver into the input of the modulator of your transmitter. If FM is to be used, it will be necessary to have the MD-168/UX modulator in the place of your present modulator.

To receive facsimile, either the TXC-1B facsimile transceiver or the RD-92A/UX recorder can be used but it is necessary to use the CV-1066A (CV-172A) receiving converter. See Fig. 3 if you wish to copy the weather stations in all parts of the world. All of them use frequency modulation. Copying weather maps (see Fig. 4) is good experience to become proficient in facsimile operations. Once you get the knack of it, you can be your own weather man.

Weather stations are located in San Francisco, Washington, D.C., Pearl Harbor, Guam, Tokyo, Kodiak, Alaska, Edmonton, Canada, New Delhi, India, Canberra, Australia, Khabarovsk (USSR), and Cambridge Bay, N.W.T. For time of transmission and frequencies of these weather stations (Fig.5). There are others in England, Germany, Turkey, Sweden, Spain, Norway, Morocco,

Call	Location	Frequency	Time of Transmission (GMT)
NHB	Kodiak, Alaska	2356 khz	0600-1800
		4825 khz	0600-1800
		8622 khz	Continuous
		12817.5 khz	1800-0600
		17045.6 khz	1800-0600
VFE	Edmonton, Canada	5360 khz	0000-2400
		8184 khz	0000-2400
		11615 khz	0000-2400
		15770.5 khz	0000-2400
NPG	San Francisco, Calif.	3268 khz	Continuous
		5345 khz	Continuous
		9455 khz	Continuous
		14927.5 khz	1500-1000
		18080 khz	1800-0600
		21785 khz	1800-0600
NSS	Washington, D.C.	3357 khz	Continuous
		4975 khz	0000-1030
		8080 khz	Continuous
		10865 khz	2300-1900
		16410 khz	0515-0000
		20015 khz	Continuous
RXB	Khabarovsk, U.S.S.R.	3980 khz	0000-2400
		4516.7 khz	0000-2400
		6870 khz	0000-2400
		7475 khz	0000-2400
		9230 khz	0000-2400
		14737 khz	0000-2400
JMH	Tokyo, Japan	3622.5 khz	0000-2400
		7305 khz	0000-2400
		9970 khz	0000-2400
		13597 khz	0000-2400
		18220 khz	0000-2400
		22770 khz	0000-2400

Call	Location	Frequency	Time of Transmission (GMT)
RJTZ	Tokyo, Japan	3205 khz	Continuous
		5960 khz	Continuous
		6940 khz	Continuous
		7938 khz	Continuous
NPM	Hawaii, Pearl Harbor	2122 khz	Continuous
		4802.5 khz	0600-1800
		9440 khz	Continuous
		13862.5 khz	Continuous
		16400 khz	1800-0600
AXM	Canberra, Australia	2628 khz	1000-2200
		5100 khz	1000-2200
		11030 khz	1000-2200
		13920 khz	1000-2200
		19690 khz	2200-1000
VFC 3	Cambridge Bay, N.W.T.	3253 khz	0215-0415
		7710 khz	1515-1715
NPN	Guam, M.I.	2554 khz	0900-2200
		3377.5 khz	All Schedules
		4975 khz	All Schedules
		6460 khz	All Schedules
		7645 khz	All Schedules
		9960 khz	All Schedules
		10255 khz	All Schedules
		10966 khz	All Schedules
		13807.5 khz	All Schedules
		15930 khz	All Schedules
		18620 khz	1900-1200
		20925 khz	All Schedules
		22865 khz	All Schedules
		23880 khz	All Schedules
WMH	San Francisco, Calif.	13642.5 khz	1800-2400
		15982.5 khz	2000-0400
WMI		10190 khz	0400-1800

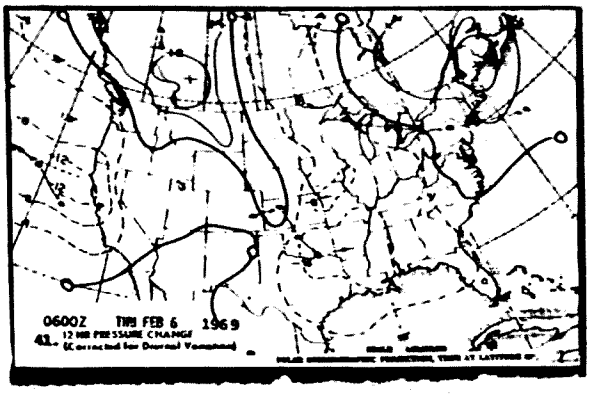


Fig. 4. A typical weather map.

Cypress and Argentina but frequencies, call letters and time of transmissions were not available at this time.

Facsimile is growing more popular each day. Here in the Southern California area there are twelve stations operating and several more have equipment and will be operating soon.

. . . K6GKX■

Mr. Steinberg's articles have been popular with 73 readers—so much so, in fact, that the author frequently found himself engaged in correspondence with his fans long AFTER publication. His untimely death, of course, cut off this correspondence flow. Mrs. Steinberg has, therefore, submitted a few of Ralph's recently received letters to 73, with the thought that perhaps they might be answered by another amateur knowledgeable in the field:

Dear Ralph,

Recently read your article in June issue of 73. I agree with you on FAX. It was a short article and very practical. I enjoyed it and must compliment you on it. I'm with the SSTV gang that meets on Saturdays at 2 p.m. (New York time) at 14.230 MHz. Please send me as much information as you can on FAX (self-addressed stamped envelope enclosed).

Philip J. Lupi WA2NHH
1225 Hillside Place
North Bergen, J. J.

Dear Mr. Steinberg:

I just found your article in the June '67 issue of 73 Magazine about the TS34AP. I have just acquired a good TS34 without the lens or hood (not modified as in your article). Do you know anyone who has made the conversion recommended by you—who still has the lens and hood and would sell them? I used one of these scopes once and would rather have the original configuration.

David Potter
2844 San Gabriel
Austin, Texas 78705

Dear OM:

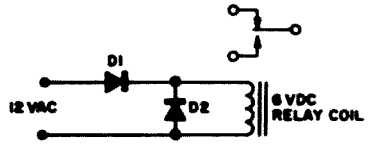
My friend Ted Cohen, W4UMF, told me about your activities in FAX. Because I am working FAX some years now and have been unable to contact some boy in the States, I ask for your help.

In past time, I contacted W2BK (Ray P. Clurmann), but recently I have been unable to establish contact with Stateside amateurs. I would like to know the systems and schedules of operation so that I may attempt a FAX QSO with you. I particularly need to know if you Americans can use the HF bands to work FAX. I regularly work 14087 kHz in FM mode (FSK), with Cooperation Index 576 or 288, positive or negative transmission, 30, 60, or 120 rpm. Some time back, I copied transmissions from States to Antartica with medium success. Is there a possibility that I might join you in FAX activity?

Ing. Hernando Vargas Martinex HK7XI
Ingenieria Electronica y Communications
Carrera 35 No. 52-75
Bucaramanga, Colombia, S. A.

USE DC RELAY ON AC WITH DIODES

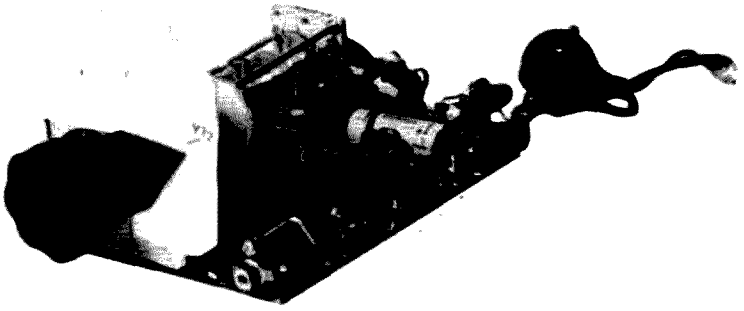
Another good way to use diodes is shown below. I needed to run a 6 vdc antenna changeover relay on ac. This is how I did it.



On the positive half cycle, diode D1 conducts, passing current through the relay coil, which builds a magnetic field. On the negative half cycle, this field collapses, and the resulting current is passed through D2, which shorts the ends of the coil together for the negative half cycle. You will note the current always flows through the coil in the same direction. Thus the relay operates as if it were on pulsating dc. In operation, there is almost no audible noise from the relay coil.

Edward Lawrence WA5SWD/6■

William Hoisington K1CLL
Far Over Farm
Peterborough NH 03458



Solid State Double Bandwidth Tunable IF Solid State Converters

This may sound like a lot of "solid state" but it does help get the idea over that there are plenty of battery-operated vhf and uhf converters on the market, but what are you going to hand-carry for a tunable i-f on that mountaintop or while camping?

Of course you can put your communication set in your car, haul an ac putt-putt along, drag it 100 feet away from the car, and *go*. It is peculiar though, the dim view Forest Wardens take of this racket going on all day Sunday with all those visitors around each paying 25¢. I did this for years and often had to lug the generator 100 feet *down* the mountain top on the side to keep it quiet.

So, our tunable i-f will help this situation, working on your favorite band, six, two, 432, or 1296 mhz, and even 2400 a little later.

Ten meters is used because that gives you a nice ten meter receiver for portable use, and when you're on 432, or 1296 you need at least 30 mhz to keep the image down.

Design Philosophy

This is a straightforward job with one rf stage, a mixer, and an oscillator, all tracking on a three gang capacitor from 28 to 30 mhz. See **Fig. 1**.

"Bipolar" (which means just the old-fashioned, regular triode type with three leads) transistors are used to keep down the cost and time of construction.

An S meter connection is shown because when you're using that high gain sharp beam up there, it's nice to know just where it does peak! And by how much, even if it's only relative.

General Notes

At this frequency, 28 to 30 mhz, almost any good vhf transistor does a good job. There is gain in the converter ahead, and gain in the i-f following, so you don't need much here. Once again, though, you do need tracking. There is a whole section on a painless method for doing this in this article.

The main tuning (or ganged) coils are all wound identically, to help in tracking, and with the exception of the oscillator collector, all other circuits are lightly coupled to them.

L1 brings in the first i-f from the 6, 2, 432, or 1296 converter, at 28 to 30 mhz on J1. If you just happen to put almost any kind of antenna into J1 you may be surprised at the ten meter signals you hear. Just incidental.

Note that for the sake of uniformity and ease of wiring all eleven coils are returned to ground on one side. This accomplished by dc blocking capacitors from the bases, which are dc fed by resistors, and by the use of the

L1	3 turns, no. 28 DCC, close wound on ground end of L2.
L2	17 turns, no. 26 DSC, on 6/32 tapped form, 5/32 O.D., with 6/32 threaded, powdered iron core.
L3	2 turns, no. 28 DCC, as L1.
L4	2 turns, wound close on L5.
L5	As L2.
L6	3 turns close wound on L5.
L7	4 turns on L8.
L8	As L2.
L9	2 turns on L8.
L10	1 inch long iron core, 5/32 OD wound for 2 mhz, two pi.
L11	4 turns on middle of L10.

Table 1. Coil turns.

collector dc voltage being at the baseboard level. Note that by this method most bypass capacitors are eliminated.

The copper-clad baseboard also makes it easy to ground all coils on one end. The capacitors are all the 1000 pf little ceramic jobs from Lafayette, 3/16ths of an inch square. C1-A, B, and C was a Bud three gang with 11 pf per section. For this unit, I removed one rotor plate from each of the three sections, and also spread the 28 to 30 mhz tuning range over 80 percent of the dial.

If you have a converter or converters having other than 10 meter outputs, you can change the coils to suit. The main reason here for choice of 10 meters was the large number of "amateur band receivers" with 10 being the only band with nearly 2 mhz tuning range. This should cause converters with 10 meter outputs to be in the majority, although I have not checked with converter manufacturers on this.

All transistors just happen to be Sprague 2N1726 (four years old right now) but you can use almost any good vhf ones, as the noise figure and gain are set elsewhere. The main deal here is to *tune* something so you can use crystal control for the uhf local oscillator where it is needed.

No critical points were found in the tune-up of this unit. For permanent use, installation in a Minibox should be used, matched to your favorite dial.

Summing up, this article is to show you how easy it is to make a good, low cost solid state, tunable i-f section as a necessary part of battery operated rigs for 6, 2, 432, and 1296 mhz. After all, isn't it better to be up on a mountain in the summer, and on the air, than to sit in the shack all the year round?

Details—RF Stage

The rf stage (refer to Fig. 1) has a tuned circuit in the base, with an untuned collector brought over to the mixer on L7. As detailed in the tracking section, the iron core is used to set the low frequency end of the tuning and the trimmer C2 sets the high frequency end. Trimmers C2, C6, and C11 also serve to spread the 2 mhz range over the dial. Battery voltage is high on the collector end of these stages which makes things a lot easier, especially for bypassing, as you will see.

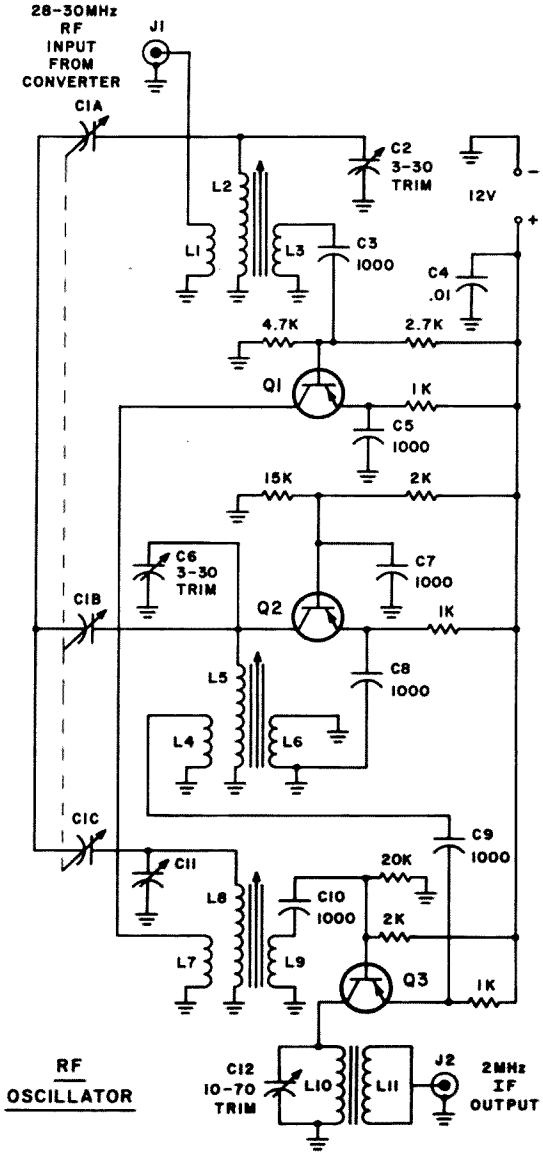


Fig. 1. 28 to 30 mhz tuneable i-f.

Oscillator

The oscillator is a sure-fire emitter coupled job, with the collector on the high end of L5. This is done to "set" L5 as the "slowest" tuning coil of the three. The other tuning coils, L2 and L8, are then made to track with a little more trimmer capacity, matching the collector capacity of the oscillator on L5.

Oscillator output is obtained from L4 and capacity coupled to the mixer emitter. Starting from ground, wind L4 on L5 in the same direction as L5's winding, and put the emitter of Q2 on the other end. It *has* to oscillate! There is a simple law of nature that says; "If a good transistor has good coupling back from a *good* collector coil so that the base goes negative when the collector goes positive, it will generate the signals you want, upon application of good voltage."

Mixer

Note first that the mixer uses the gang capacitor section furthest away from the rf section. The rf stage has never shown any sign of nuisance feedback in this tuner so far, but it's a good precaution anyway, to keep those sections apart. No shielding was needed either, but you might just need some if you try to make the unit smaller. It's six inches deep, by five inches wide by one and three quarters high now, not including the dial.

Tuned energy from the rf collector is brought to the mixer on 4 turn coil L7, and local oscillator input is capacity fed to the mixer emitter. The output coil L10 was tuned to 2.5 mhz in this unit, although you can use a little higher or lower if you want.

As a general rule a ten to one conversion frequency is good, but you are on a trade-off here: a high ratio will make your next i-f more selective but your image possibility will increase. A low ratio will make the image disappear but then you haven't done much conversion and you may need *more* converters to get you down to the final i-f you're counting on. More on this in Part Two where the "double-bandwidth i-f" is detailed. This is where you build a diode into each i-f section with separate volume controls for instant mixing into one af amplifier. This will give you broadband for quick and easy search, and narrowband for demodulating that weak signal from two states over!

Special Separate Section on Tracking

There is a very straightforward positive method for lining up coils for ganged capacitors, which will be detailed here, using the 28 to 30 mhz tunable i-f of this article as an example.

We start here with the circuit already designed and working correctly with three separate capacitors, one of which may be the oscillator section of the gang used.

The ganging together of the frequency versus rotation of the three section variable capacitor is not a matter to be taken lightly, however. Due to slight differences in the circuitry of the rf, mixer, and oscillator stages and their coupling, it is not enough to buy three movable iron core coil forms, wind six (example) turns on each coil, and expect them to track. The grid-dipper will not do the whole job either, although it may help some to get you started.

The first thing is to cover the range needed with the variable capacity of one of the sections of the gang, and still leave some capacity at the high end for the best Q. This residual capacity is furnished here by the parallel trimmers, which are of considerably greater capacity than the ganged sections, so that the L/C ratio actually changes very little over the range tuned.

Assuming you already have chosen the ganged capacitor suitable for the frequencies involved, which appears to be less than 10 pf per section (as I had to remove one rotor plate out of three from an 11 pf unit), check out which of the three stages takes the most variable capacity to tune the range. This will generally be the oscillator stage in this circuit. This is the one you will line up first because it is easier to stretch the frequency over the dial than it is to compress it.

Referring to Fig. 2, we will be concerned with connecting and disconnecting the three points shown, which will be designated hereafter by rf, mixer, and oscillator.

Now, using the completed unit, with two external capacitors temporarily tuning the rf and mixer stages, and operating into the i-f

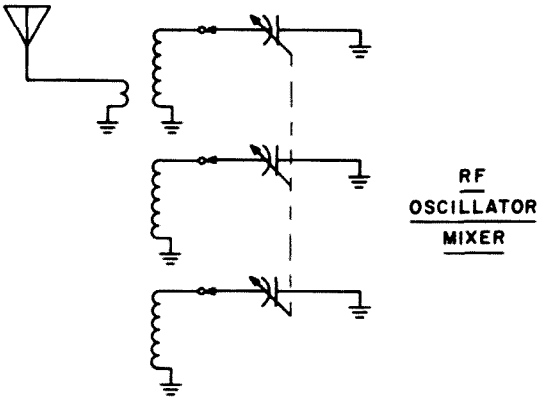


Fig. 2. Major connections for tracking.

you are going to use, such as 2 mhz, be sure everything works correctly, such as sensitivity, tuning range, absence of feedback in the rf stage, etc. Use an "S" meter or avc meter for this work. Tune the oscillator with one of the three ganged sections, and log three or five frequencies on Table 2. The dial must be in its permanent form. I used 28, 28.5, 29, 29.5, and 30 mhz for this purpose. The dial may also have any other scale as well on it that you may wish to set up, such as 431.9 to 434.1 for example. To make this unit you do need a signal generator, at least one of the $30 to $40 kind.

Some "quickie" manufacturers use only three points on the dial such as max., middle, and min., but that results in a $9.95 "radio." If you want to do a real job use five spot frequencies (as suggested above) for the 10 meter band as i-f for this tuner.

You can use 30 to 32 if you are afraid of rf leakage input from the 10 meter band. This whole unit should be ready to install in a Minibox with a good cover, so you should not have any trouble with i-f leakage on any frequency.

MHZ	RF	MIX	OSC
28			95
28.5			74
29			53
29.5			28
30			10

Table 2. Dial logging scales.

Now log on paper, the five frequencies chosen on a simple chart as in Table 2. You can see now the basic idea of this system. You have a positive, visible, and exact recording of the tracking of one of the gang

PROPAGATION CHART

J. H. Nelson

JANUARY 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	14	21	21A	21
ARGENTINA	14	14	7A	7	7	7	14A	21A	21A	21A	21A	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14B	21	21	21A	21A
CANAL ZONE	14A	14	7	7	7	7	14	21A	21A	21A	21A	21
ENGLAND	7	7	7	3A	7	7B	14	21A	21A	21	14	7
HAWAII	21	14	7B	7	7	7	7	7B	14	21A	21A	21A
INDIA	7	7	7B	7B	7B	7B	14	14A	14	7B	7B	7B
JAPAN	14	7A	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO	21	14	7	7	7	7	7A	21	21A	21A	21A	21
PHILIPPINES	14	7B	7B	7B	7B	7B	7	14B	7B	7B	7B	7B
PUERTO RICO	14	7	7	7	7	7	14	21A	21	21	21	14A
SOUTH AFRICA	14	7B	7	7B	7B	14	21	21A	21A	21	21	21
U. S. S. R.	7	7	7	7	7	7B	14	21	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21A	21A	21A	21A

CENTRAL UNITED STATES TO:

ALASKA	21	14	7	7	7	7	7	7	14	21	21A	21A
ARGENTINA	21	14	14	7	7	7	14	21A	21A	21A	21A	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	7B	14A	21	21A	21A
CANAL ZONE	21	14	7	7	7	7	14	21A	21A	21A	21A	21
ENGLAND	7	7	7	3A	7	7	7B	14A	21	14	7B	7B
HAWAII	21	14	7B	7	7	7	7	7	14	21A	21A	21A
INDIA	7B	14B	7B	7B	7B	7B	7B	7B	14B	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO	14	7	7	7	7	7	7	14	21	21A	21A	21
PHILIPPINES	21	14	7B	7B	7B	7B	7B	7	7	7B	7B	14
PUERTO RICO	14	14	7	7	7	7	14	21A	21A	21A	21A	21
SOUTH AFRICA	14	7B	7	7B	7B	7B	14	21A	21A	21	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

ALASKA	21	14	7	3	3	3A	3	3	7	14	21	21A
ARGENTINA	21	14	14	7	7	7	7B	14A	21	21	21A	21A
AUSTRALIA	21	21	14	7A	7B	7B	7B	7B	14	21	21A	21A
CANAL ZONE	21	14	7	7	7	7	7	14	21A	21A	21A	21A
ENGLAND	7B	7	7	3A	7	7	7B	7B	14A	14	7B	7B
HAWAII	28	21	14	7A	7	7	7	7	14	21	28	28
INDIA	7B	14	7B	7B	7B	14	7B	7B	7	7	7B	7B
JAPAN	21A	21	14	7B	7	7	7	7	7	7B	7B	21
MEXICO	21	14	7	7	7	7	7	14	21	21A	21A	21A
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7	7	7B	7B	14A
PUERTO RICO	21	14	7	7	7	7	7	14	21A	21A	21A	21A
SOUTH AFRICA	14	14B	7	7B	7B	7B	7B	14	21A	21	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14B	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21A	21A	21A	21A

A = Next higher frequency may be useful also.
B = Difficult circuit this period.



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sections set up. Leave the oscillator core and trimmer set from now on so that these settings do not change unless a new start is to be made. This sometimes happens!

Now take the oscillator off the gang and solder the rf on. All you should have to do now for the rf is to set the iron core to trim the low end of the range, and the parallel pad trimmer to set the high frequency end. It's not always that easy though.

Right here you may have to do some readjustment of circuit values, and possibly some hard work! The rf may not track in the middle after lining up both ends! Or vice versa.

This is the reason for those funny-looking saw cuts you may have seen in the two outside plates of millions of ganged capacitors for over forty years! However, with the components and circuit shown in the overall schematic you will probably make out all right, although this section is intended to help you use other components, as well as helping on other frequencies.

The procedure is fairly straightforward now. Just make the rf readings coincide with those of the oscillator previously recorded by adjusting the core and the parallel trimmer. Using less core (that is, the core further out of the winding) and more trimmer you will of course "stretch" the readings on the dial. Make several runs this way and you will soon get the hang of it. And, you don't have to guess, it is logged down on paper for you.

Mixer

Now disconnect the rf, connect the mixer, and proceed as above. You should now be able to fill in the third column and be ready for the big deal.

Oscillator and Three-Gang Tracking

If the oscillator has been previously logged correctly, and the other sections fitted to those readings, on soldering all three together you should have no trouble. Don't fiddle too much with the adjustments after soldering all three connections back onto the gang, because you have no means of knowing what the curve of any one section, except the oscillator, will be.

The reason for some gang capacitors having different oscillator and rf sections, is mainly because the broadcast band has a three-to-one tuning range in frequency, whereas the oscillator for a BC band radio needs about a two-to-one tuning range.

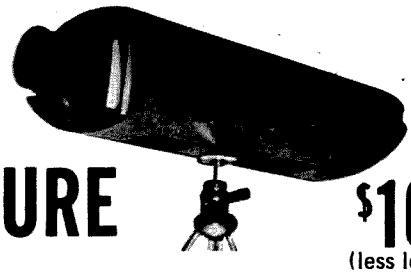
When you are running at 28 mhz however, and the mixer is at 28 to 30 mhz, the oscillator is only some two mhz away. The tracking ranges are so close to being identical that no effect can be noticed. So in this case use a ganged capacitor in which all the sections are alike.

That's about it for this positive method of tracking procedure. It has always worked for me since 1928!

Conclusion

All you need now is your favorite band converter in front, one or two fixed tuned i-f strips following, two lantern batteries for a 12 volt supply, an af amplifier, a crystal controlled transmitter, another af for modulator, a good portable beam, a carrying rack of plywood with shelves, a walk-up mountain, and the right companion!

... K1CLL ■



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(continued from page 9)

to find more bores per square inch than at any other time in our cycle. We are fed a diet of indigestible pap, the asininity of which is so transparently designed - solely to get our votes - as to be intolerable!

But don't imagine for a single moment that only American politicians conform to this sorry pattern. Other lands, far-flung and remote, suffer greatly from this same lamentable pathological disorder. They too are faced with the same loudmouthed, self-proclaimed geniuses, spouting the same claims of omniscience, with the same panaceas and nostrums for curing all the world's ills. (I do believe that when certain foreign politicians threatened that they would one day bury us, they really meant that they would bore us to death!)

The main trouble with politicians in general is that they have absolutely no sense of humor. They refuse to regard themselves with anything less than utmost seriousness. They are sublimely pompous because they claim to have absolute solutions for evils which have existed without any solution since the earliest beginnings of mankind. I sometimes think that they create some of these problems deliberately, so as to use them as fulcrums upon which to poise their perpetual quest for public office.

Years ago, and for what seemed an interminable period, a pig farmer in Secaucus, New Jersey, persisted vainly in running for the Presidency. Now, in retrospect, and speaking with serious objectivity, do you suppose, really, that he would have done terribly worse than some of our recent Presidents, governors, or mayors? Truly, I am inclined to doubt it.

* * * *

I've always found it fascinating to speculate upon the odd and wholly illogically logical sight of a clergyman blessing an artillery piece, a torpedo, or a rocket launcher on the eve of battle. Undoubtedly this monstrous distortion takes place on both sides, so that Providence must eventually either choose a preference through favoritism, or throw up the hands and ordain a pox on both houses.

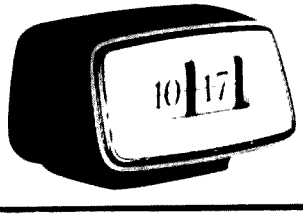
Enlightened societies long ago dispensed with that old anachronism, the divine right of kings. But they have never quite overcome the perverted morality of religious righteousness of military adventure. Somehow there has developed a duality between armed conflict and religion. Saint Joan was above all a soldier. The Crusades were holy wars. Kings were called "Defenders of the Faith." And the most heinous cruelties ever known were committed in the fifteenth century by the Inquisition, a quasi-military arm of the church, whose entire thrust was based upon punishment for the crime of heresy.

I do not know, nor can anyone calculate the numberless masses slain in holocausts which were countenanced and blessed by religious authorities. From the time of the Israelites and Phillistines upon the plain before Shochoh and Azekah, and even before that, when Joshua chose out men in Rephidim and fought Amalek, people have perished in agony, fighting i n wars sanctioned by Divine Authority. The entire lexicon of mankind is filled with examples of this carnage, running through the tapestry of our history like a scarlet thread.

Is it not a strange and inexplicable wonder, that all the combined prayers of wives, sisters, fathers, mothers, and brothers have not had the potency of a single incantation, mumbled over an artillery shell or a fragmentation bomb by a military chaplain?

It is possible, of course, that our world has periodically been weighed in the balance, as in ancient times, and has been found wanting. It is likely that Armageddon will continue to recur over and over again, until we humans finally decide to beat our swords into ploughshares.

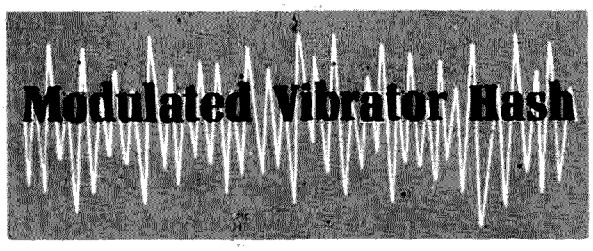
(continued on page 96)



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VHF-FM: A New Involvement

The call "K6MVH" on the masthead of 73 will doubtless cause the eyebrows of about 4,000 subscribers to raise an inch or so. That's how many 73 readers there are who also receive monthly FM Magazine, a "splinter-group" publication that I have co-owned and edited for the past several years.

What Ever Happened to FM?

FM Magazine almost went the way of all prior splinter mags. Like VHF Horizons and the VHF'er, FM Magazine was well received by the amateur radio operators but virtually ignored by the advertisers. The journal was costing more than it was making. Mike Van Den Branden, its originator, paid for the enormously expensive printing, binding, and distribution costs; I paid for the typesetting cost and author remunerations. But there came a time when the costs were simply too much for me to bear. I accepted employment with an out-of-state firm, and was forced to abandon my expensive but pleasurable hobby of supporting the financially ailing FM journal. My partner elected to stay with it. He cut costs by thinning down the magazine and changing the page size, and is determined to make it go. He deserves success.

The fact that so many amateurs were active in FM (with repeaters, mobile telephones, and remote base stations) was sufficient justification for me to want to stay in the field. So, after turning over my share of FM Magazine to Mike Van Den Branden, I got in touch with Wayne Green.

To my mind, Wayne is a smart cookie; he is ever watchful for trends and new things. He was publishing articles about the real FM while the other journals were ignoring the fact that FM existed except as a switch position on a piece of AM gear. And lately, he has been emphasizing the repeater element even to the extent of personally communicating with as many repeater owners as he could to get information about frequencies, operating practices, ideas, and such.

73's Role

So it was that I proposed to Wayne the initiation of an FM/repeater segment of 73 Magazine. Categorically, 73 is opposed to departmentalized publications. Wayne's experience began in an amateur publication that was so departmented structurally that little room remained for general technical articles. His feelings along the lines of columns, multipart articles, and departments have not changed to this day. But Wayne shares with me the thought that FM operation is a cow in another stable. What was once a splinter group has become a chunk group. And it promises to engulf an even larger share of VHF operation in the immediate future.

Thus Wayne was not particularly keen on the idea of a column, but he could see the need for intensified coverage of the fast-moving field of repeaters, remote operation, and amateur FM. As a counterproposal, he suggested that I move to New Hampshire and serve as editor of 73, where I could work in FM articles regularly as a balance to the already abundant fare being served up monthly for all phases of amateur radio. It meant broadening my interests, of course, but a quick self-appraisal revealed the desirability of this—so, I packed my bags.

Now that I've been sold on the other interests amateur radio has to offer, I feel obligated to tell others about the advantages of FM. (Let's ALL be well balanced.)

The reasons for the popularity of FM are as varied as the interests of the operators, as any seasoned FM'er will attest. But FM's strongest points are these: Getting started is easy, and the results are more than proportionate to expenditures—particularly where repeaters are involved; there is an acknowledged superiority of equipment performance and operation over AM equivalents; and finally, FM is still an area where innovative thinking, pioneering, and experimentation are possible, in such branches as control design, link interconnection and deployment, telemetry, and even public relations.

That's the background. Now, 73 Magazine will carry FM articles with regularity. They may be technical, construction, instructive, generally informative, or conversion types, and they will be geared to the needs of the new discoverer of FM as well as the long-time operator. 73 will attempt to carry the same overall philosophy as it has carried with the entire magazine in the past: plenty of meat for every reader of every level, every month.

Spread the Word

There is lots of room in 73 pages for articles, and the pay has never been better. So those of you who have come up with a better carrier-operated relay for a repeater, or who have developed an antenna that gives better vertical separation, or who have found new ways to get higher repeater sites, start writing. Show the rest of the world

photos of what you have done, schematics of what you built, or system diagrams of what you have designed. And watch these pages to see what the others are doing.

... Ken Sessions ■

Ed. Note.
For those new to FM, Ken Sessions' recently published, hardbound "Radio Amateur's FM Repeater Handbook" starts at the technological rockbottom and goes right through all the simplified details of building a repeater and keeping it on the air. His book is currently available at all major electronic distributors or from the publisher, Editors & Engineers, Ltd., New Augusta, Indiana.



BCI in Stereo

Some transistorized stereo systems are susceptible to BCI from *rf* energy in the 3.5 to 30 mhz range. What happens is that the long lengths of the speaker leads and power cord act as antennas, feeding *rf* energy to the first audio stage where it is rectified and amplified in succeeding stages. The solution is to add ferrite chokes in each lead.

The ferrite chokes consist of a 3" piece of ferrite rod about ¼" in diameter or larger, wound with at least 25 turns of each speaker lead and power lead. Begin winding as close to the chassis as possible. Some units are equipped with plugs for each speaker lead, which is a good place to begin. The speaker leads are usually zip cord as is the power cord, so that when you have at least 25 turns of wire wound on each rod there will be about three layers of wire on each which can be held in place with any ordinary tape you have available.

The ferrite rods can be obtained at most radio supply houses as ferrite antenna coils or loop sticks. They come with a coil of wire on them which is removed and discarded. Some rods are 6" in length. To make two 3" pieces, score the rod with a file at the 3" length and tap it on a hard surface and the rod will break cleanly.

After installing the chokes in each speaker lead, try out the system, both radio and record player; you may be lucky and not have to choke the power cord. But if there is a trace of BCI in either the radio or the record player add the power line choke, again beginning the winding as close to the set as possible, although it will probably work if you begin winding at the plug end of the cord.

...K1ZYG

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☐2-200V units $1.00
☐1-500V unit $1.00
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(continued from page 93)

There has to be an answer to all this somewhere. I find it hard to understand how anyone can place other considerations higher than this one on his list of priorities. Everyone in this world should be hoping, praying and working for peace. And, for a change, we ought to be blessing not cannons, but school books . . . not machine guns, but construction tools and agricultural implements.

If we do not accomplish this change now, we may not get another chance to do it. As the highway signs says . . . "Last stop before exit!!!"

* * * *

There has been a ridiculous emphasis on bust fetishism over the past twenty years or so, which has proliferated into gigantic proportions, no pun intended. We seem to have carried this mammary-mania so far that it appears unlikely for it to develop further (again no pun intended) short of making the topless fad universal.

Now, for myself, I object strenuously. When there is nothing for the imagination to conjure, what is left?

There were times in the past when the same shamelessness became an accepted way of life. The ancient Etruscan ladies adorned their bodies with jewels, metals, cosmetics and heavy drapery, but allowed their bosoms to remain bare, a display which was thought to be esthetically attractive. But it did not help the Etruscans to avoid falling into ruin. The Roman legions, unhampered by the distractions of abundant feminine pulchritude, were able to beat the Etruscans into submission, without any difficulty whatever. Thus perished one of the earlier powers of Europe, a victim of its own unhealthy preoccupation with prurience.

From what I have seen of the open display of the female thorax in the more primitive areas of the world, it seems clear that these manifestations occur in direct inverse proportion to the degree of civilization. Most of these savage societies are throwbacks to the prehistoric eras, with scant development of agriculture, communications, or transportation. They consist principally of tribal groups, limited in area, governed by taboo and ju-ju, unaware of the slightest advance in the human state of being.

It would probably be quite pleasant to spend lazy days and soft nights lolling on the tropical South Sea sands, or listening to the plashing of river wavelets lapping at the banks of an African savannah, while tall, statuesque, ebony- or cinnamon-hued Venuses slink seductively by. I can even dream of being handed a tall, icy drink of what-you-may-please by an amply endowed vixen with soft-as-velvet epidermis whose sole function in life is to make me realize my masculine irresistibility. But when I think of riding in the New York subway on a chilly February morning gazing at huge expanses of pale, flabby, goose-pimpled, naked flesh, somehow the picture of the tropical idyll fades into the background of forgetfulness.

A friend of mine, hungry as a ravenous bear, unsuspectingly stopped in at a place in Greenwood Lake, where they employ topless waitresses. He had in mind a juicy sirloin, french fries . . the whole bit. When the waitress came over to take his order, he arose, stumbled spastically to the bar, ordered a bourbon boilermaker, and went his way . . . a chastened and a shaken man, mumbling to himself.

So, if you don't mind, I take my stand against all this open display of superdeveloped thoracic anatomy. Down with the Playboy centerfold. Down with cleavages, uplifts, and bikinis. A fellow has to be able to reserve something for quiet contemplation and solitary appreciation. If all our secret little fetishes are permitted to flourish out in the open, we might start to cultivate vices that are truly harmful and destructive. Three cheers for purity, modesty, chastity.

* * * *

Well, there you are . . . and as the dentist said, "Now that wasn't so bad, was it?" We've covered the three taboos, and I doubt whether I've trod on anyone's toes, or hurt anyone, or violated many sensibilities.

It occurs to me, now that I think of it, that all the objections to having discussions about these allegedly sensitive areas has, for years, been based upon a false footing, a subterfuge. While it was always stated that these topics should be avoided so that no one's feelings might be hurt, the true reasons for the proscription was something altogether different. Such discussions tend to examine the underpinnings of society, the basic structure and nature of the entire human community. A too close scrutiny of these elemental foundations is very apt to disclose some dry rot. And it is to the advantage of certain groups and individuals within society to preserve the status quo and resist change. People have been conditioned to avoid such analysis.

I have a suspicion that the strongest and most vocal opponents of free discussion on these points are not at all concerned with the delicacy or indelicacy of such dialog at all. Political discussions are not viewed with favor by political scoundrels and grafters. Religious discussions are not popular with bigots, zealots, and fanatics. And sexual discussion is unpalatable to evil-minded puritanical, inhibited, perverted, or otherwise abnormal misfits. Everywhere they see revolution, blasphemy, and carnal sin.

There once was a well known sect called the Shakers, who believed that man's physical nature must be contrary to the Almighty's design - the work of the devil, therefore a sinful thing. They did not even countenance procreation among their own community, with the inevitable consequence . . . the Shakers disappeared from the scene. As did the dodo bird, the wooly mammoth, and the pterodactyl before them, they were unable or unwilling to adapt, so they became extinct. In the struggle to overcome a hostile, changing environment and survive, all species must evolve, adapt, accommodate. For the environment invariably prevails . . no matter how strongly the changes may be resisted.

Inexorably, our world will become more and more aware of its true nature. The thought censors do not enjoy an optimistic prognosis. In time they will be forced to give way altogether, for truth is on the march. All revolutions need not be political. Revolutions of the spirit of man are ever so much more drastic. The spheres of materialistic concepts ... money, power, war, possessions, and others, may still be in the forefront of man's interest and desire. But there is an irresistible motion toward a great and mighty goal ... a fulfillment. Tiny quantitative changes, all but imperceptible, will result in a tremendous qualitative leap .. total intellectual emancipation.

There is nothing so powerful as an idea which comes into its proper time. There is nothing so futile as an outworn principle, fighting against time and progress. Change is inevitible, and we are going to see many changes. There is a new world a-coming, a brave, new world of tomorrow. Those who refuse to change along with it are going to become extinct. It's just that simple.

... Dave Mann K2AGZ ■

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de W2NSD/1 (continued from page 2)

Are Sub-bands Meaningful Today?

In the early days of amateur radio, when phone operation was first invented, it raised such hob with CW that it was split off into the higher parts of the bands, the frequencies that no one used much. This was just fine with the pioneer phone men because they didn't like those confounded CW signals in their phone band any more than the CW men wanted the mass of heterodynes that made up the phone bands.

By the 30's we had 100 khz on 20 and 75 meters for the Class A operators. Both bands generally were jammed up tight with about ten solid kilowatt signals. When one of these rock piles would go off you could hear ten weaker heterodynes coming through the gap from ten lower powered hopefuls. No wonder that about 90% of the activity was in the CW bands in those days.

Phone DX was worked outside of the American phone bands. Few DX stations had signals that could cut through the enormous heterodynes that filled our phone bands. In the good old AM days it took about two stations to have an unreadable pileup.

Then came sidebands and the layers of heterodynes gradually died away. We began to hear more and more DX operators working right in the American phone bands. Today most of the phone DX is worked in the American band, with the exception of an occasional backward DXpedition operator.

Now that AM is about gone from our DX bands, perhaps it is getting to be time to do away with the concept of separate American and foreign phone bands? For that matter, with the percentage of amateurs using CW growing smaller every year, perhaps the time is not far away when we will be able to do away with sub-bands entirely? I'd like to see it given a try for a while to see how it works out.

The present day CW op has filters available that can virtually remove sideband. The sideband op can virtually remove CW, if he uses a couple of notch filters. Our bands can hold many times the number of phone and CW signals that they could a few short years ago just because receivers have come such a long way.

I note that a group of amateurs is about to petition the FCC to open the phone bands for an extra 100 khz on 75-40-20 meters. Good plan, of course, but why not go all the way and open all frequencies to everyone? Instead of taking more and more frequencies away from the active operators, why not give them all more? Is there really that much harm to be done? We could try it for six months on one band and see what happens!

ARRL Board Meeting

The special November meeting was supposed to come up with recommendations for the FCC regarding incentive licensing frequency changes. Unfortunately the FCC didn't wait for the advice, so the Board found itself with a lot of little matters and no main topic. The 1970 national ARRL convention will be in Boston. Fine. I hope that 73 will be permitted to attend this one ... the last Boston National saw us excluded by personal directive of Huntoon.

The board agreed to petition the FCC to grant counterpart call letters to amateurs moving from one call area to another. I'm glad they did this. But I do wish that some interested ARRL member would buy a subscription to 73 for the directors so they would know that this petition has already been entered. I reported this in October on page 127 as RM-1455. If any one of the directors or the headquarters gang had read 73 they would have known that this had been done. A reading of the FCC actions would have also alerted them about this. I'll bet you'll never guess who sent in the petition to the FCC originally. Heh, heh!

... Wayne ■

NASTAR/MOONRAY

RTTY/SSB Broadcast Schedule

Broadcast times are GMT on Tuesdays. This is Monday EST. There will be no broadcast on the first Tuesday of each month.

0001	14.090	RTTY to Europe
0015	14.090	RTTY to Africa
0030	14.235	SSB to Europe
0040	14.235	SSB to Africa
0200	14.090	RTTY to southern USA
0210	14.090	RTTY to western USA
0300	14.235	SSB to southern USA
0310	14.235	SSB to western USA

LETTERS

Dear Wayne,

Without question, your magazine is by far and away amateur radio's superior publication. In the September issue on P. 134 was a letter by Arthur Woods W4GJW in which he made many suggestions for new subject matter for your magazine. This I heartily endorse.

I would like to see owners reports of manufactured amateur gear such as those automobile owner reports in Popular Science, etc. Proper editing would bring out the strong and weak points or limitations of each piece under investigation. Simple modifications could be thrown in, if desired. The series would be self perpetuating by asking at the end of each article . . . Owners of the Super Whamee Mark IX (or whatever gear desired) please send your comments to 73 Magazine.

I am certain that a series of this kind would be successful as hams from around the world would feel that they are contributing in a small way to a fine publication as well as to amateur radio. I can't think of an easier way for amateurs to get involved.

Stan Pugh WA7KSC
2521 North Proctor
Tacoma WA 98406

Dear Wayne,

Been reading 73 now for several years–just like I read CQ when you were running the show there. Even met you once in San Antonio at the Gulf States Convention about fifteen years ago! So long?? Anyway, I have enjoyed the reading.

Like a lot of other hams I am also interested in making things that are not always for the ham-shack. Right now it is metal detectors. I'm wondering if there aren't a bunch of other readers who have the same interest. I would like to swap circuits if anyone wants to and I would particularly like to have a good BFO circuit using a crystal controlled oscillator on 100kc–like the unit made by White's Electronics in Oregon.

So how about it? Can someone do an article on the subject? Or just print this letter–maybe someone will come up with a good one.

Les Spoonts W5WWX
1600 S. Jones Dr.
Arlington TX 76010

Dear Wayne:

In the ". . .de W2NSD/1" portion of your issue for November, at p. 126, I seem to read an echo of my letter of March 7, 1969 to you–under Public Relations. I do understand that QST has now retained a PR consultant, or some such. Hope the rumor is correct, or that it at least indicates a change of attitude.

Hopefully, this may all lead to some constructive effort to lobby *for* amateur radio in Washington. Too often I have found that PR work, per se, merely serves to lock the barn after the horse has been stolen. Your very pertinent remarks concerning the obvious results of the implementation of Docket 15928 seem to me to show pretty clearly that horse, barn, and most of the crops are long gone.

Of course all of this, involving frequencies, spectrum utilization and amateur population are matters that many of us brought to the attention of ARRL and FCC when 15928 was first weaned. That our protests were very generally ignored must by now be accepted and recognized as a great disservice to amateur radio by those whose declared reason for being was the orderly and constructive development of the hobby, art, service or whatever one likes to call it.

I can remember when very few amateurs had a good word for that hot-headed radical, W2NSD. I suspect that if a poll were taken today you would be considered something of a dedicated prophet! Some miles northwest of you there is, in Hanover, a college that has the motto–"Vox Clamantis In Deserto," or something like that. My recollection is that it means something along the lines of "A Voice Crying In The Wilderness."

It must be so with you. It can only be hoped that in some way the larger body of amateurs will really listen to what you have to say, and will give tangible support to a movement towards a sane and constructive program to give vitality and purpose to the amateur game.

Al Smith W2AFJ/K3ZMS
Penury Priory
Doylestown PA 18901

Dear Wayne,

I sure do like your magazine and its unbiased (?) opinions. What I really wrote about, however, was to enlist the services of anyone who knows the "magic trick': how to use the Central Electronics 10B as an SSB exciter with the Heath TX1 Apache transmitter. Also, any teens or Novices wish to start a net on 15m? Please contact me.

Gregg Marco WN6IZT
2880 Ridgeway
San Bruno CA 94066

Dear Wayne,

The reason everyone is so interested in "sex, religion and politics' may be that most amateurs are far behind the professional world in technical matters.

The biggest problem seems to be that manufacturers of components gear themselves for industry not the individual amateur. There are integrated circuits that contain an i-f amplifier, and detector including AGC. Another IC for the audio, a third for the rf, add a couple tuning coils and a speaker and you have built a high performance portable receiver. With the manufacturer's data sheets, you don't even have to know how a transistor works to have a good time building.

But there is the problem: How does the average ham find out about the latest circuits? The only way seems to be to read trade magazines and write for data sheets. Either that, or wait until some other ham does so and writes an article for 73.

What we need is more information on these new devices so hams need only read amateur magazines to keep up to date. Maybe the ultimate would be a special ' newsletter" for amateurs only.

What say?

Paul Zander WA8JCM/9
25-5 Ross Ade Dr.
W. Lafayette IN

Dear Mr. Green;

It is seen that the growth of 73 Magazine is like that of the field in which you are dedicated. This may seem to you as a way of saying congratulations to you and your staff for this is true.

It is with great sadness that it is easy to see that there are those who cannot see that the use of that which is called, telegraphy, is that which cannot serve the growth of the nation. There was a time when the state of the art was such that telegraphy was all there was. When we see the advancements which are known to us today, we see that telegraphy is not responsible for these advancements. We see that these advancements would not have been possible had it not been for those who saw that telegraphy can never serve in the successes of the electronic control systems of all kinds which were used for positive control in the automatic control of the space program and in industry as well. High speed Teletype has replaced telegraphy. All of this gives more work for many more people in a growing country in the sense that electronic technicians far outnumber the few remaining telegraph operators.

In the public view, the repair of an electronic device or a television set requires a technician. In the public view, the public does not look for a telegraph operator to repair a television set or any of the electronic devices which the public uses and/or enjoys. This is to say, telegraphy is not important to the public.

When we see this, we see that the public will never be convinced that telegraphy can serve them in their needs. Their needs are not that which telegraphy represents. In the public interest, telegraphy is not known nor is it needed.

Telegraphy is like a man who lost one leg. He cannot walk as can a man who has both of his legs. The previous paragraphs explain this in other words.

It is seen that there are those who seem to believe that telegraphy is needed in order to prove that a technician is not a technician unless the technician knows telegraphy. We all know that this is not true for we see that a knowledge of telegraphy can never repair a television set or any electronic device used in the public interest. This clearly tells one, there is no need for telegraphy in industry and commerce of a nation. It is seen that this is true.

When we see that the military services have been abandoning telegraphy for more exotic means of communication, it is seen that the military services recognize the fact that their only use of telegraphy is in battle. Even here we find that the military frequently uses equipment which is not designed for telegraphy in the sense that voice commands are more quickly understood. We refer here to armies committed in battle and each knows the others position. We find that there is no time to be lost in these conditions. This is to say, not even telegraphy serves here.

It is seen that there are those who believe or who seem to believe that it is necessary to provide a limit or to limit the number of radio amateurs in the belief that telegraphy is the means which they see as being effective. The manner in which this has been done in the division of the bands is seen as that which the Government of the United States cannot do in the sense that the Government cannot discriminate. It is seen clearly that this division discriminates against some and in favor of others.

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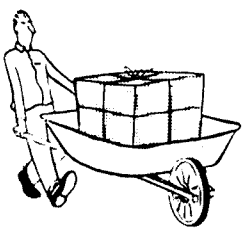
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73 Magazine Peterborough NH 03458

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This is to say that the Government is not an individual who can select his or her own friends.

The selection of one's own friends results from common interests or common desires. Electronic theory is not easy to learn and is never fully learned. Those who know electronics are those who know this to be true. Those who do not know electronics find that for them it is not that which interests them. This can be said of any profession. The practice of medicine is an example of this.

It can be seen that the interest in electronics is that which has given and will continue to give more technological advancements which are in the public interest. It can be seen that the amateur bands have provided the radio amateur with the means by which he does develop a technical skill which industry needs and which industry does not provide. Industry wants a man already trained. It can be seen that were there to be no amateur bands there would be no developments in industry. It is the radio amateur who has been responsible for the technological advancements.

Industry requires men who are trained in all of those fields which are available to the radio amateur who is a technician. The only reward for a radio amateur is a greater knowledge which he has gained.

Mr. Lin Carol
Avenida Cometas 180-B
Colonia Contry
Monterrey N.L. Mexico

Dear Mr. Green,

I have been subscribing to "73" for several years, and I think it is getting better with each issue. I wish to add my thanks for the Advanced and Extra Study articles. They are much clearer than many other study guides, and contributed greatly to my getting the Advanced ticket. My code speed is improving gradually, and I will have the Extra one of these days.

I hope you will allow me to comment on some of the issues which you and others have raised in letters and articles which you print. First, I disagree with W1DIS's opinions (page 40, Nov. issue) on what can be discussed on the air. There is nothing in FCC regulations which says we cannot use the ham bands for an open forum. For those who have not read it or cannot find their copy, subpart E of FCC amateur regulations says ONLY that, "NO LICENSED RADIO OPERATOR OR OTHER PERSON SHALL TRANSMIT COMMUNICATIONS CONTAINING OBSCENE, INDECENT, OR PROFANE WORDS, LANGUAGE, OR MEANING." (Par. 97.119 FCC regulations). I have gone over these regulations time after time and nowhere can I find any other mention of what we can or cannot talk about. In other words, I believe the FCC gives us the benefit of the doubt that we will conduct ourselves on the air with common, ordinary decency, and if we do otherwise as stated in Par. 97.119, we can expect our tickets to be suspended. I will, therefore, discuss any subject with anyone in as gentlemenly a manner as I know how, but will break off or refrain from such a discussion if it becomes ungentlemenly!

I do not agree with those who are fussing about the difficulty of the license exams. The FCC uses only 98 words to describe the basis and purpose of Amateur Radio, (Part 97.1), and these words include the following; ". . .provide emergency communications; . . .advancement of the radio art;

. . .rules which provide for advancing skills, . . .trained operators, technicians, . . .". An old timer told me many times that anyone can learn the code and can increase his speed if he is willing to practice, so those who gripe about it are just plain lazy. The FCC provides the Citizens Band Radio Service for those who do not care about advancing their skills or improving themselves as a trained operator.

For those who do not like the present incentive licensing program, I suggest they write the ARRL and also write the FCC even if it takes 14 copies. Here are my suggestions for a better incentive licensing program, and I have written my ARRL director, and intend to write FCC also:

1. Drop Advanced Class license.

2. Restore to Generals the frequencies allowed prior to Nov 22, 1968, in the interest of public service.

3. Allow Extras to use phone in what is now known as the "Foreign" phone segments.

4. All licenses except EXTRA class, should be non-renewable. Conditional should be for only one 5 year period except for disabled with doctor's certificate stating inability to travel. Anyone else should be able to find his way to an FCC office or field examiner sometime in 5 years.

I can hear the moans and groans about having to take a new exam every 5 years, but how else can we fulfill the basis and purpose of Amateur Radio if we don't upgrade ourselves? I hope you will print this letter to get some reactions, and also maybe it will stimulate some more thinking on how to improve the situation.

J. W. Harrison, Jr. WB4TBX
1234 Little Bay Avenue
Norfolk VA 23503

Dear Editor:

I am writing to commend author R.J. Zach and the editors of 73 Magazine for the series of articles on FM. We are in favor of any means of furthering the cause and have noted that several articles on the subject have been recently published.

I have noticed, however, that only one of the many articles published (Bill Orr's in Ham Radio) even mentioned the existence and availability of any new equipment made for the amateur market. I think it only fair that some mention of this new equipment should be made–not only of the Varitronics-Inoue line, but also of several other manufacturer's equipment–so that your readers will know that used gear is not the only thing available.

I am enclosing specification sheets on our current models for your information. Again, thanks to you and the editors for furthering the FM cause.

Sharon LaTraille
Vice President
Varitronics, Inc.

See editorial "VHF FM: A New Involvement" and "Low-Cost Electronics: Japan's FM Invasion," this issue. . .ed.

Wayne Green:

I have subscribed to 73 for four years, now, and it IS the best that I have read. I also subscribe to Ham Radio, QST and CQ, so I think that I have all the numbers covered. 73 Magazine, in my opinion, gives me the greatest pleasure of them all and I shall stay a very satisfied one–till death due us part, or something. I passed the Advanced without

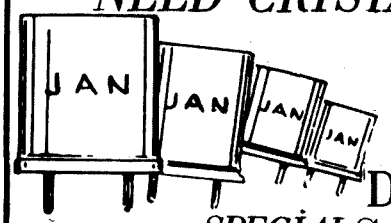
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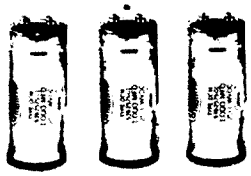
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your help—no sarcasm intended, and would pass the Extra—if you could get the FCC to lower the CW to 15 wpm. What is this—proficiency in CW or theory? Of course, as you have surmised, I am excellent on theory and lousy on CW, but I am honest. I am writing like mad to QST and directors, to forget the second half of this incentive thing, which, I am Afraid, will kill or set back Am. Rad. Anyway, good luck to you.

Jack Golden WA2YPW
Portville NY 14770

Dear Wayne:

There are occasions upon which I wish you would base your writings upon fact.

On page 127, November 73, you state that I publish two magazines on a commercial basis complete with ads and subscriptions. I do not *publish* any magazines whatever. I do *print* three. The Auto-Call is published by the Foundation for Amateur Radio, of Washington, D.C., a fact which can be determined from the address side of any issue. The DARA Bulletin is published by the Detroit Amateur Radio Association. The ARNS Bulletin (surely you're not accusing this one of being commercial?) is published by the Amateur Radio News Service. Each of these is printed in my basement on the basis of materials cost only without any charge or retainer whatsoever for labor or machine depreciation. Each publisher receives, directly, all money for subscriptions, advertisements or dues and any profit (or loss) accrues directly to them, not me.

I am gratified that you are concerned about the time I spend in printing these publications, but I can assure you that only a small portion of my time is involved in the printing.

Since you are now set up for printing (page 129) I would be most happy to turn the entire affair over to you, providing you will do the work at the same price.

For your information complete financial details of my entire operation were furnished the members of the Executive Committee of the ARRL who passed on my eligibility for Vice-Director, and who adhered strictly to the provisions of Article 12.

I insist that you print this letter in its entirety as a correction to your statements.

Ralph V. Anderson KØNL
Vice-Director
Mid-West Division, ARRL

My Oxford Universal Dictionary defines a publisher as, "One whose business is the issuing of books, periodicals, music, etc., as the agent of the author or owner; one who produces copies of such works, and distributes them to the booksellers and other dealers, or to the public." The dictionary says nothing about profit. You admit in your letter that you are issuing periodicals and distributing them to the public and this makes you a publisher, whether you or the Executive Committee like to call it that or not. Article 12 has been violated, obviously. . .Wayne.

Dear Mr. Green,

Mr. Hartley's recent article ' Religion, Politics or Sex' has raised two basic ideas:

1. Why can't amateur radio be a forum for exchange of ideas? There is nothing wrong with calmly discussing politics, where a real dialogue exists and ideas and ideals are exchanged and expressed. People who object to one's ideas must

either learn to accept other's ideas or change frequency.

2. To preserve our society, we all must learn to accept each other's ideas, and accept his right to say his ideas any time and anywhere he wishes. (If he breaks the rules, he must be punished, however.)

It is ironic that we have the fantastic communication capability, but we have nothing of any value to say to each other.

James Altman WA0UWL
1921 Pinehurst
St. Paul MN 55116

ADDENDA & ERRATA

APOLLO TV & RADIO (Nov. 73) Addenda: An adjustment should be made for Westinghouse Electric Corporation and Radio Corporation of America as follows. The monochrome TV camera used on the Apollo 7 and 8 space missions was made by RCA, as stated. However, the monochrome TV camera used on Apollo 11, which was left on the lunar surface, and the monochrome TV camera used on Apollo 9 was made by Westinghouse as well as the color TV cameras for Apollo 10 and 11. The statement to the effect that the RCA camera was utilized in Apollo 11 and 9 was based on incorrect information. I am thankful for being corrected.

Thomas Laffin W1FJE
Hillsboro NH 03244

Dear Wayne:

The error on page 76 of the November issue of 73 should read: "This is possible if we assume that the dc current gain hFE is much greater than one, and that the collector current is very nearly equal to the emitter current." This is because the high hFE makes the base current much much smaller than the collector current. Recall that the emitter current precisely equals the collector current plus the base current.

I have received letters, but I was surprised to receive a couple of long distance phone calls. Letters are fine because it gives me time to sit down with the magazine and work out an intelligent answer, but a phone call catches me suddenly without a chance to think, and I usually can't give an answer right off.

Cliff Klinert WB6BIH
520 Division St.
National City CA 92050

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Elliott S. Kanter, W9KXJ

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HAM-AUCTION February 1, 15th Annual by Toledo Mobile Radio Ass'n, at the Lucas County Recreation Center, 2901 Key St., Maumee, Ohio. $1.00 Registration, open table sales, map and further information—write Ron W8STA, 4654 Monac Dr., Toledo OH 43623.

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SUPER GAIN (R) ANTENNA much gain, makes exciter sound like linear. See pgs 8 & 144, Oct. 73. GUERILLA (R) high efficiency ant. See pgs 57 & 113, June 73.

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GREENE. . .center dipole insulator with. . .or without balun. . .see 73, November '69, page 107.

DIAL PLATES: all types. Give your home brew and other gear an attractive appearance. Send for catalogue. Radio Dials, 1397 Washington Circle, Forestville OH 45230.

WANTED: Turret Tuner with coils or all chassis with tuner for Hammarlund SP400X receiver. Later model with 13 plate stator & 14 plate rotor. Ralph M. Williams, Box 372, Dixfield ME 04224.

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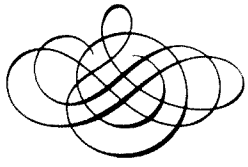
WANTED TEST EQUIPMENT HP608 generator, RX meter, 704 Jerrold FSM, 601, 900 Jerrold sweep generator, HP130 oscilloscope or equivalent. VE3BVX, 11 Sussex North, Lindsay, Ontario, Canada.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

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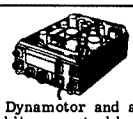
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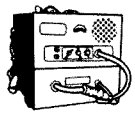


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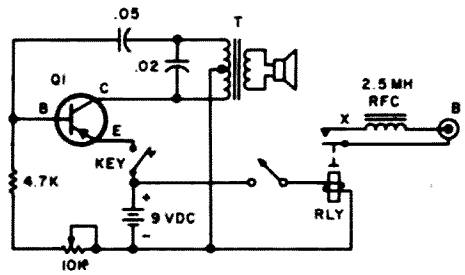
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The circuit is very simple; a single PNP audio transistor in a common base configuration. All parts except the relay and choke came from a discarded transistor radio. It will work well with any general purpose audio transistor and an NPN may be used by reversing the battery polarity. The key acts as the oscillator switch, and switch SW controls the keyer.

Be sure that the choke is placed directly at the relay points and short the contacts with a small by-pass condenser at the point marked X, keeping the leads as short as possible. This will eliminate chirp and key clicks.

The relay can be any very small make and break type that will operate at the battery voltages and must draw very little current or the battery will not last long. Make sure the relay will work at the speeds you operate, and that it does not chatter.

The entire unit can be housed in a small black plastic meter case (3½x6x2 inches) available from Lafayette for about 75 cents. It has enough spare room to house a small power supply should you desire to include one.

The keyer will key any type transmitter as long as the relay contacts will stand the current and it will need no reverse blocking diodes.

The ten K pot is a tone control and resistance is not critical and may be changed to suit taste.

The keyer requires no practice to learn to use and can be built for a few dollars at most. It is just the thing to tuck in your pocket for Code Practice at Scout or club meetings.

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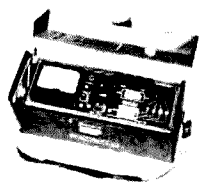
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Ham Hospitality

Dear Wayne, OM

We have just received our June issue of 73 Magazine. Big deal, but this was relatively fast, as many issues arrive 3 to 4 months late, due to the mail service here.

I note that on page 119 your article about hospitality for hams. Since we have been here in Brazil for over five years, and speak the language fluently, perhaps we can assist any hams who may wish to visit Brazil. We would be delighted to have a "casal," couple stay with us in our home, and I (the XYL) would be glad to take any XYL shopping, while the OM made visits to other localities, such as our kinescope factory, record factory and if they wish to buy precious stones in the state of Minas Gerais (where we have our receiving tube factory), I can assist them there also. We lived in that state for over three years, and I have learned quite a lot about stones.

Just remember that this country is large, and Recife (where some people visit) is about 1000 miles away, HI! Any one coming to Sao Paulo is more than welcomed. Our home phone number is 62-4530.

Continue to work hard, but at the same time enjoy your work! As yet Brazil does not have reciprocal licensing so we are not on the air, but we know many hams here who are always anxious to meet American hams.

Let us hear from you!

Frances L. Gunther-Mohr
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73

No. 113



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73 MAGAZINE

#113, February 1970

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World's cheapest rig.

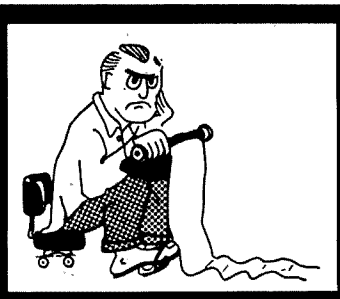
134 A Simple Integrated Circuit Q-Multiplier **W2EEY**
Makes the CW band ten times wider.

137 Quick Stop and Reversing for Antenna Rotors **PY2AUC**
Whipping antenna whip.

73 Magazine is published by 73, Inc., Peterborough, New Hampshire 03458. Subscription rate: $12 for three years, $6 for one year. Second class postage paid at Peterborough, N.H., and at additional mailing offices. Printed in Pontiac, Ill.

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This issue is all right, but wait until you see the Giant March Surplus Catalog Issue next month! If you dig surplus, stand by for mind-boggling. You don't like surplus? Oi.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

Crowded Bands

If you, too, have been involved with amateur radio for some thirty years, I think you'll have to agree with me that one of the big all-time complaints has been QRM. Even those with sixty years of hamming under their belts will tell you that from the first day of their operating, QRM was murder.

Since, in practical application, QRM can be largely avoided, I suspect that most of the true sufferers from the condition are masochists, unduly stubborn, or perhaps just not too swift. At one time in our history amateur radio was rather well known to the general public, though the image they had was one of young boys staying up all night in attics. I'm not sure that even that image is better than not having one at all, which is about the shape we're in these days.

Green's Law

If you insist on forcing amateur radio to fit your convenience, you may be a sufferer from QRM. The evening hours and weekends are the most convenient, so that obviously is when there are the most stations on the air . . . and the most QRM. These are prime times for developing a mental hernia trying to get a short ragchew on 20-40-80. Meanwhile, up on 2 and 6 meters, this heady peak of activity will, in many parts of the country, give you a choice of two stations to contact instead of one. Green's QRM Law No. 1 (an extension of the Finagle Principle) tells us that if there are just two contacts on a band, they will probably be just about on the same frequency and will be QRM'ing each other.

The RTTY gang can be heard typing up a storm with little interference, and, lonely of the lonely, the Extra Class CW ops can be heard during peak operating hours all huddled near one frequency down in their exclusive bands.

If you are too stubborn to head for the wide open spaces of 2 or 6 meters, don't dig typing out your contacts, and don't cotton to the untrammeled higher frequencies on 10 meters, then perhaps you could bend to the extent of changing your operating hours a bit? I may be ruining a perfectly good thing for myself by telling you about this, but the bands are almost empty in the early mornings. That's when you'll hear *me* operating.

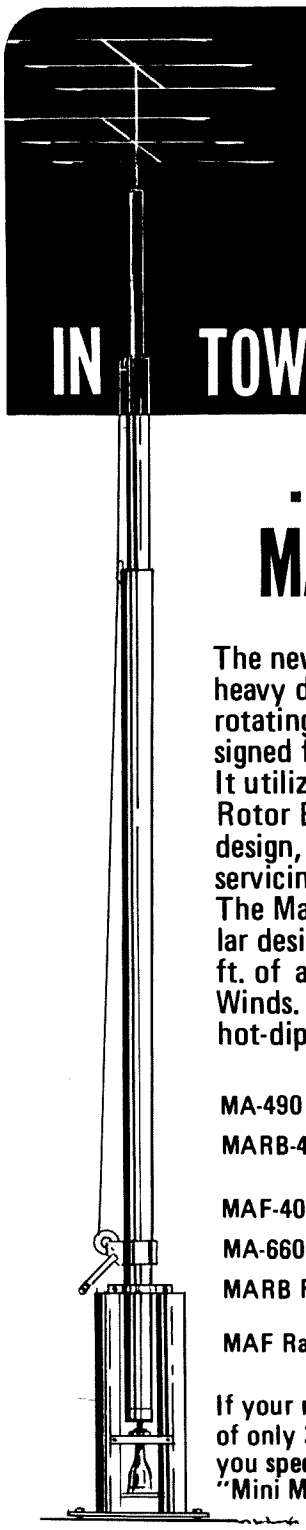
Generally I'm in bed by 10 p.m., which means that along about 4 a.m. or so my eyes open up and I either lie there staring at the ceiling or else get up, get dressed, and head for the office, a twisty 10-mile drive through the New Hampshire hills. After fixing a quick breakfast I head for the rig and see what is doing. The signals are few, but the band is most certainly open and the contacts are generally free of QRM. In winter I can usually work just about anyone who happens to be on the air in Asia, the Pacific, South America, Antarctica, and even Europe.

Don't Follow the Pack

A little trick I learned the hard way nets me a lot more DX than the average operator. Now and then you will hear me in a pileup, but most of the time you'll hear me *starting* pileups, not continuing them.

After listening to the gangs of operators trying to get through to rare spots, you may get the erroneous idea that the op in the rare spot has it easy—any time he gets on he is loaded with fellows trying to contact him. It doesn't work that way. This fellow has a good deal of frustration because he is in an out-of-the-way spot.

The problem is that when Europe is coming through to the States, almost every beam is pointed at Europe. The fellow down on a small Caribbean island can call his fool head off and no one will hear him. I remember one particularly frustrating time. I had just received my license to operate as VR2FD in the Fiji Islands and I fired up on 20 sideband. The band was hopping . . . this was going to be fun. I heard Dorothy K2MGE in a roundtable with some other friends and I called in. Nothing. I tried breaking. Nothing. After a half hour of trying to break between every leg of the roundtable, I heard Dorothy say she thought she heard someone trying to break the QSO. My relief was short-lived. The next station came on and dismissed me with the remark that whoever was trying to break in was not cutting the mustard. They never did stand by for me. I tried up and down the band for another hour, calling CQ, answering CQs and trying to break in on friends. The VRs that were in the shack with me explained that it is always like that. Everyone has his beam pointed toward Europe and there is little chance of getting through.



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If your requirement is for a tower of only 30 or 35 feet let us send you specs and prices on Tristao's "Mini Mast". It's a little beauty.

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Butler, Missouri 64730 816/679-3127

Eventually I snagged a KH6 and a couple of the more alert W6s heard the contact. Suddenly there was a pileup and I was busy handing out contacts as fast as I could. You could almost hear the rumble of a thousand beams turning all over the U.S.

Now, when I get on the air from home, I seldom point my beam along with the crowd. If they are working Europe I swing my beam around and call a CQ toward Asia or the Pacific. If they are working the Pacific, then I call for the Indian Ocean or the Mid-East. These directional CQs work for me. Just yesterday I contacted VK6GK mobile (VK6 is the antipodes from up here), 9V1OH, and VU2GE. The VU was running 15W of SSB, by the way. More often than not, a directional CQ like that will bring in something rare, giving you a contact that you otherwise might have to spend hours working for, fighting the pileups.

. . . Wayne

Gentlemen:

With regard to your Christmas photo in the December issue:

We've looked at the picture–examined the scene,
Which is quite reminiscent of Mad magazine.

We've paid close attention and Lin Green looks nice,
And so does Dot Gibson–ditto Phil Price.

Walt Manek looks sad through a grin that's excessive.
Is that what you call a Manek depressive?

Horray for Diane who in mini looks racy
And hello there to Roger and Don and Jane Tracey.

Hi, to Joe, Jeanne and Wayne–the rest of the cast–
And now for the best which we've saved for the last.

Your gang sure appears like a fun-loving group
And we quite hate to throw an old fly in the soup

But all through the years, in hamming, in life,
In all of the good times, and all of the strife

Past all tribulations–past winnings and losings
Past days being sober, and days filled with boozings,

You can torture us, mangle us, freeze us or fry us–
There *can't* be a girl named Whitney Tobias!!

Jules E. Blitz
7934 Winterset Ave
Pikesville MD 21208

Dear Reader Jules: much thanks for your poem.
It has spiced up the air at our magazine's home.
As to your comments about Lin and Dot,
We agree with you fully–they said "Thanks a lot."
Phil Price thought it funny–he shed a small tear,
And our Manek depressive is no longer here.

As for Diane, well she accepts, with a wink,
And Roger and Jane say "Hi, Jules," I think.
Our Joe and our Jeanne send 73's,
And Wayne, our big chief, completely agrees.

Yes, we are a fine bunch, and we do have much fun,
But your fly in the soup is such a bad pun.
For in truth and in friendship (I'm not being pious),
There is truly *a girl named Whitney Tobias.*

. . .Diane Shaw



AN
EDITORIAL
BY K6MVH
KEN SESSIONS, JR.

Why This Issue of 73 is Dedicated to WA8UTB

This is an obituary.

An entity that lived fast and hard and well has passed. This living thing was FM Magazine. For me it was a promise unfulfilled. For Mike Van Den Branden it was a dream turned nightmare. For a world of new people–the repeater men, the two-way hams, the FM pioneers–the death of FM Magazine was the loss of something that was uniquely their own.

Mike Van Den Branden WA8UTB was the originator of the magazine, back in February 1967. He put out a sheaf of duplicated papers and called it FM Bulletin. Everything seemed right. There was a general turning to FM on our VHF amateur bands that was to grow beyond everyone's belief. And the Bulletin was to become the widely approved and unanimously accepted voice of this new and expanding group.

Matching the contagious popularity of the mode, the publication expanded too . . . until it seemed the bulletin-turned-magazine would bust apart. It went from duplication to lithography. And within months it was a well dressed slick with four-color cover and professionally prepared interior that could stand abreast with the best of the well established old-time pros.

I was editor of this magazine, and shared the ownership with Mike until it nearly broke my back. When I gave up, he carried on, assuming responsibility for a financial burden that would make Rockefeller cough.

Oddly, Mike Van Den Branden was not in the publication business for the money. He was one of those rare, one-in-a-lifetime types who follow a dream because of the dream. Mike believed in FM as a communications mode. And he believed his magazine filled a definite need. This is not to say that Mike would not have been pleased to see his "baby" turn a profit; but he was not once discouraged by the fact that it never did.

And Mike was always willing to bear the financial brunt of new ways by which his baby could be improved. If you happen to be one of the very very few fortunates who have a complete library of FM, you know the metamorphoses that characterized the 3-year lifespan of FM Magazine.

This is the end of the obituary of FM Magazine. But it by no means marks the end of the Mike Van Den Brandens. So maybe a toast is in order:

Here's to the dreamers.

Buffalo Hams Influence Rulemaking in Canada

The members of the Buffalo Amateur Repeater Association are to be congratulated; for these individuals, who spent many long and arduous hours drafting a detailed and comprehensive petition to the FCC concerning the operation of repeaters in the VHF amateur bands, have achieved at least a degree of success. The efforts of Gil Boelke W2EUP, Francis Stengel WB2GUG, and a handful of others of the BARA organization have not gone unnoticed. Some time ago, Canada's regulatory agency, the Department of Communications, sought guidance in laying out a plan of rules for prospective Canadian repeater licensees. Using the Buffalo petition as a foundation from which a set of realistic regulations could evolve, the DOC recently published a tentative mandate that will

serve as "interim regulations" until such time as permanent rules for amateur repeaters are passed into law.

Of the mandate's seven points, at least four had been put forth in the famed Buffalo petition, and several of the others were unofficially advocated by BARA representatives in letters drafted after the petition was originally filed.

The points of significance to repeater owners are:

- Licensee will be responsible for TECHNICAL operation of the repeater, including ultimate control over any amateur's access (or the access of a restricted group).
- Licensee will maintain a TECHNICAL log showing malfunctions, servicing data, on-the-air tests, etc. (This precludes the necessity for running a continuous tape log of operation, presumably, and is the essence of the Buffalo petition.)
- Repeaters will identify at one-minute intervals by transmission of the repeater call sign at reduced amplitude.
- Links are to be in the frequency range above 220 MHz, but they are exempt from the aforementioned identification requirement.
- The licensee is required to put a three-minute automatic shutdown transmitter on each of his remotely controlled transmitters. And it must be rigged in such a way that only the licensee can turn the transmitters on again once they are shut down.

These rules are a step in the right direction, and they serve to show that the Canadian government is on its toes with respect to what's happening in the amateur world there. But there is one aspect of the rules that has frightful implications. I can only hope it is a mistake in wording, because it can serve no useful function of itself and can only result in making repeaters in Canada less utilitarian for the many users.

The rule I am referring to, of course, is the last one cited above. The mandate specifically states that when a repeater is timed out at the end of a three-minute period, it must be reenergized by the licensee only. In practice, virtually all repeaters–both in the U.S. and in Canada–are already equipped with such timers; when an incoming transmission exceeds a duration of three minutes, the repeater (and usually the links) shuts down. But reactivation is typically automatic; that is, when the longwinded individual drops his carrier, the repeater can be energized again by the next incoming signal.

Ostensibly, the Canadian ruling was put forth to assure technical control under all conditions. But the DOC should be made aware that such control could be assured in a variety of other ways, nearly any of which would result in a more useful, reliable system. For example, the licensee could transmit a control signal that would positively (rather than passively) shut down the transmitter when such shutdown is warranted. Or he–or anyone else using the repeater–could keep the system shut down by transmitting a continuous low-power carrier on the input frequency until positive control was effected.

There are a variety of means for achieving the same end. But the finality of automatic timeout suggested by the mandate does not seem to be in the best interest of the amateurs who will depend on the reliability and dependability of a repeater that will frequently be shut down by individuals who can't seem to turn themselves off after 2.999999 minutes of talking.

An interesting sidenote: QST published a short note about the Canadian doings in the December issue. Several ARRL directors were credited, but there was no mention of the effort expended by the Buffalo group. I consider this a bit odd, considering the fact that the ARRL has had a copy of the Buffalo petition since the time it was filed, back in 1967.

Repeater Petition to Get Docket Number

A repeater rulemaking petition was submitted to the FCC on December 3, 1969, and is currently undergoing processing so that a docket number can be assigned. The petition is too lengthy for reprinting here, but here is the essence of it:

1. An amateur repeater is officially recognized and defined.
2. Repeaters to be made legal on all frequencies where AØ is authorized.
3. Timed shutdown is required after long non-use periods.
4. Repeaters can be turned on from the frequency of operation provided that UHF control is capable of overriding such turn-on, when necessary.
5. Repeaters can be "unattended," since shutdown is automatic when repeater is not used. It can thus be assumed that the repeater is being monitored (from the frequency of actual use) when it is on. The petition seeks to dispense with "UHF control" monitoring in favor of the "on-when-used, off-when-not-used" approach, which is essentially "unattended" operation, but with a realistic and workable twist.
6. Repeaters should not be logged in the conventional sense. A log would consist of a few basic particulars and would be filled in only when the remote repeater is visited, serviced, or modified.
7. Repeaters should be identified at 3-minute intervals, and the ID can be nothing more than the repeater call letters, in Morse code or voice.

(continued on next page)

There are more than 300 FM REPEATERS in the U.S...

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The SAROC Funfest

In case it's slipped your mind, time is running out for those of you who haven't made advance reservations for SAROC, the Stardust Amateur Radio Operators' Convention, to be held on February 4 - 8 at the Stardust Hotel in Las Vegas. The SAROC funfest has been getting bigger by the year, and indications to date are that this year will top all previous records.

For the nonteetotaling among you, SAROC will offer a number of advantages for you to mooch free booze; cocktail parties are being hosted by the magnanimous managements of Swan, Galaxy, and Ham Radio.

National FM Convention. Ham FM'ers should take particular note because SAROC serves as an operating base for the annual national FM convention. Tom Burford W7TDQ is the principal representative for the FM portion of the shindig; and if you drop him a card, he can give you the details on the FM programs slated for this year (which, incidentally, marks the third annual national FM convention to be held in conjunction with SAROC). Tom's address is 6328 Shawnee Ave., Las Vegas.

At this writing I have no idea as to what the agenda is, but I can guarantee that it will be interesting. Last year, a national repeater group was formed, and national repeater frequencies were adopted. There were a few disappointing problems associated with FM scheduling last year, but most of these were attributable to apathy on the part of the hotel management. Switching of SAROC from its previous base to the Stardust has solved these potential headaches, I hear.

If you have gripes about 73 or its policies, or if you have pet circuits you want to see printed, grab me at SAROC. I won't be hard to spot; just look for the guy who has the "special deal" on subscriptions.

Reservations. If you don't know how to get your reservations or how much money the affair will cost, send SASE to SAROC, Box 73, Boulder City, NV 89005. You'll get the details back fast.

. . . K6MVH ■

LETTERS

Audible 73s

Dear Mr. Green:

Someone mentioned to me the possibility that your magazine was being recorded on magnetic tape for the use of interested blind persons. If this is true, please let me know where I might apply in order to borrow these tapes.

Oliver K. Mixon W4DJF
Augusta-Richmond County Municipal Building
Augusta, Georgia

Recorded tapes of 73 are available from:
Science for the Blind
221 Rock Hill Road
Bala Cynwyd PA 19004

Hospitality Notes

Dear Friend,

I am very interested in your Ham Hospitality scheme and hereby offer my home for any visiting hams, especially Stateside DX.

My interests are ham radio, organ music, and politics (I am a City Counselor, Johannesburg). XYL is 45 years old. Her interests are cooking, garden, stamps and politics. We have two delightful dogs (our children are married and live elsewhere) and, apart from two full-time servants, we live alone.

This offer is made in all sincerity–no strings attached. Visitors and their children would be made very welcome. We love having guests and would be offended if any offer of payment is made. Reciprocity one day is all we expect. Are there any California hams who could house Corrie and self over December 1970? I would like to write to them.

Dan Mahony ZS6OS
PO Box 1729
Johannesburg, S. Africa

Help!

Editor:

I would like to purchase or scrounge, whichever is applicable, RCA publications:

RCA Silicon Power Circuits.
Application sheet SMA36.
Application sheet SMA40.

Also, any data re ICs used in FM i-f strips at 10.7 MHz and 455 kHz, narrowband (±5 kHz) quadrature detector, etc.

John C. Meyland VK3AMI
Wangaratta, Vic.
Australia 3677

Study Courses

Dear Wayne:

I hold an Advance ticket, Wayne–thanks to your very fine recent series devoted to helping amateurs climb the ladder. The exam–which I took and passed last week–was a cinch, only because I *understood* every question and could answer all with equal comprehension. Any amateur who feels he can pass the Advance exam by memorizing the ARRL license manual is fooling himself. It just won't work. Incidently, your November editorial correctly observed that the emphasis is now on SSB and transistors. It should be. Needless to say, I have accumulated and digested your Extra lessons, and this exam, too, I expect to be a breeze (thanks to your very fine handling of the material). My only problem is my code speed, which I hope to bring up to 25 wpm.

Charles J. Vlahos WB2ICV
Managing Editor
Plant Operating Management
205 East 42nd St.
New York NY 10017

TVI Case

To the editor:

The other day I spent some time at a friend's house, and as I was leaving I borrowed five or six copies of 73. When I reached home I sat down to glance through this magazine and ended up devouring one issue. It was sheer pleasure to sit down and read interesting material, page after page. As you can tell, I am sold on 73.

I believe now is the time to express an opinion and ask a question. First the opinion.

In your February 69 issue of 73, on page 36, is an article "$1,000,000 TVI Suit Filed." I read this through twice and wondered if 73 was the only amateur magazine interested enough to speak out. I found five issues of QST, for the months of February, March, April, May, and June 1969. I could not find one word about this "amateur world" law suit.

Now for the question. Would you please inform me of the outcome of this case, and does Grid W4GJO have the backing of the amateur population? I hope that this will not pose too much of a problem, but I am interested, as all hams should be.

I wonder why, after two years of QST, I never wrote a letter; but after one weekend of 73 magazine, here I am.

Daniel G. Willis, SSgt, USAF
CT2AS/WA2BDA
Box 183, 1605 CAMS
APO New York 09406

As a result of the exposure accorded the case in 73, the defendant has received assistance from a number of sources: From the ARRL, he received (without strings attached) a mimeographed list of suits involving tower cases; and from fellow amateurs, he has received a great many cash donations, which have been used to assist him in paying for the burdensome legal fees. Grid Gridley W4GJO, the defendant, tells us he is extremely grateful for the publicity in 73 and the support from within our fraternity. He reports that the suit has been dropped under a mutual agreement.

Self-Appraisal

Dear Mr. Green:

Having just gotten my October issue of 73 and having just read the letters column I want to make my opinion heard. We want to encourage new blood in the hobby. Introducing new people to the phone bands is most certainly not the way to do it.

We want to show them our better side. But the question is, what is our better side? I have yet to find the better side of ham radio (better side in my eyes). The phone bands are made up of hams that couldn't copy 3 words a minute of code, discourteous people, old people that scorn the "new breed" of appliance ops, and young people, who scorn the oldtimer–a lot of good ops and fine personalities. The CW bands are made up of dead segments where you can call for hours without a contact, segments so crowded that no one can copy anyone, and you have essentially the same crowd thinking much the same way as phone men with either the man thinking about getting one of those higher grade licenses and trying to get up his code speed, or you have the group that think the phone men are all lids that can't copy a word of code and are only slightly better than CB'ers.

The lure for many newcomers is the old farce of communicating with amateurs in foreign countries. In two years I have had calls from 18 countries. But I haven't *communicated* with them. I've communicated with three countries (one was an American working in a foreign embassy). I started in ham radio to find out what it is *really* like in Iron Curtain countries. Oh, you can talk to these countries. You usually have a long QSO of maybe 30 seconds if someone isn't continually tuning up on you. Some people are lucky enough to be able to communicate with foreign stations. They are usually the ones with 2 kW linears, big multielement beams on tall towers, with expensive gear.

And we really expect to compete with CB and SWLing? W4PZS is certainly correct in saying "they have divided the amateurs." They pushed incentive licensing through, even though there was much opposition (and much more apathy).

I am having much trouble saying exactly what I mean. Just the same, I think amateur radio is awfully lucky to get any newcomers that keep at it and get their General (or any of the others). After all, what does amateur radio really have to offer a newcomer? Many of the statements that might have once been true about amateur radio don't seem to even apply to amateur radio now.

Jim Pruitt WA7DUY/AFB7DUY
111 Hirschbeck Heights
Aberdeen WA 98520

New FM'er

Dear Wayne,

I have decided to become a ham and I am studying for a Technician license. I plan to go on 2 meters FM, but I am having trouble locating an FM unit. I hope they are not expensive! I am not in an ideal antenna location and might have trouble mounting a large array. I hope I can get good distance with a less expensive antenna. I have heard of hand-operated rotors from the old days and if I could find such a system, it would be practical since my shack would be in the attic.

I hope there is enough activity on VHF FM so that I can get some good QSOs. I started interest in FM when I heard so many 80 meter AM hams talk about such 2 meter nets.

My main interest would probably be ragchewing and possibly DX (especially when the aurora kicks up, as it sometimes visibly does up here). I have most of the technical part of the exam wrapped up and the code speed is coming, slow but sure.

Rae Shortt

Lots of FM gear available. Check the Double Bonus subject index in the back of this 73.

More Backlash

Dear Wayne:

Your recent thorough treatment of the incentive licensing problem, relating it to the miscalculations emanating from Newington, were excellent. Keep up the good work.

I detect a groundswell of considerable magnitude on this matter, with everybody giving up on ARRL as the source to look to. In this state hams are writing directly to the FCC to lodge their protests.

I suspect that Newington will change its mind eventually . . .as soon as ARRL revenue drops off and salaries must be cut.

Louis R. Huber, President
Northern Films
Box 98 Main Office Station
Seattle WA 98111

Still More Backlash

Dear Wayne:

It is not often I write letters, but after reading so many comments in your magazine and also in another magazine I thought I would also comment.

I did not think the ARRL's incentive license plan would be worth very much and it seems I was right. I don't know what the extra education necessary to get the Extra Class license is going to do for the greater number who get it. If they are going to follow a commercial radio future, it might be of value; otherwise, I think at least 99% go out and buy a shack full of equipment as soon as the license comes. The ARRL representatives at the Dayton Hamvention admitted the reason there was not too many homebrew projects in QST any more is there are no homebrewers any more.

Why should there be so many classes of licenses? I think after a Novice license any citizen with a capability of 5 or 6 wpm of CW and the knowledge necessary to operate properly should be able to get a license to operate anywhere on any band available to hams. When you go for a driver's license it would be the same to have the instructor tell you that with your limited mechanical knowledge, you could not drive a Cadillac; only a VW until you could upgrade your knowledge. The temporary permit to drive is the same as a Novice–and after you prove you can obey the driving laws, you get your license to drive on any highway in any auto you choose to buy. Why should not any ham, having obtained a regular "license," be able to go into a store and purchase any piece of "ham" gear, then take it home and put it on the air?

The sooner something is done to allow every citizen the rights he is entitled to in this country, the sooner we shall have peace.

Harold D. Mohr K8ZHZ
5670 Taylor Road
Gahanna OH 43230

Manitoba Centennial Award

Dear Sir,

A copy of the starting date, rules, etc. for our 1870-1970 Manitoba Centennial Award is enclosed. We would appreciate it very much if you would publish this:

The Amateur Radio League of Manitoba will present certificate awards to amateurs submitting proof of the requisite contacts with amateur radio stations in Manitoba. All contacts must be made after Dec. 31, 1969. Contestants must accumulate 100 points. W/K, XE, and VE stations receive two points per contact; all other stations receive five points per contact. (A contact consists of exchanging signal reports.) Contacts may be made on different modes on each band, but cross-mode contacts are not allowed.

Two different members of the Amateur Radio League of Manitoba will be designated "Bonus Hams" each month. Contacts with these stations will be worth double points.

Contestants should send a copy of their log and two IRCs to:

Mr. J. N. Knowles VE4JK
PO Box 365
Carman, Manitoba, Canada

Reciprocal Trade

Dear Mr. Wayne:

I am an Indian radio amateur with call VU2JEZ and a 3 yr subscriber to 73. I am a high school student and India's youngest radio amateur.

Well, it was a sort of impossible urge that made me write this letter to you, hoping that you will understand and sympathize with my problem:

In India out of the 500-odd amateurs, all depend on war surplus and homebrew equipment. The maximum amount an Indian ham spends on a rig is $50 - $75.

I have built my transmitter myself, and I tried to get a BC 348 working (which I had bought on the junk market). But all efforts failed. Well, now I have saved about $100 after two years. I got my ticket 6 months ago, and I'm still not on the air. What I want to propose is this: You ask some other amateur to send me a ham receiver (used will do) and I shall send him Indian goods (antique carvings, paintings, embroidered shawls, etc.). I make this proposal because import restrictions do not allow cash payment.

Thus, he can send me this receiver as a gift and I can send what he wants as a gift!

Or, if he prefers, I can give the money in Indian currency to any of his relatives in India or the USIS in Bombay.

I know I have said what I have to say rather clumsily but, I sincerely hope that you understand my situation and will help me out by dropping a hint to some of your vast multitude of U.S. amateurs.

I shall certainly remember you all my life long for having helped me to get started in amateur radio.

Gopal Kamat (VU2JEZ
Municipal Soc,A/8, L. J. Road,
Mahim Bombay-16 INDIA

Two Cents' Worth

Dear Wayne,

A couple of comments and opinions on articles in the December issue:

1. Topographic maps now cost 50¢ each. Inflation has hit the U.S. Geological Survey too. The Bureau of Land Management has some attractive maps of many areas of the West; available free (the price is right) from BLM offices located in state capitals. These have almost as much detail as the topographic maps.
2. The Swan TV2's instruction book contains a drawing of proper connections for a switch to avoid cable changing from the TV2 and its exciter. It even gives the Swan part number. I got one of these, plus two cables with the Jones plug already attached from them and threw together the switch–without resorting to coaxial relays (no pain, no strain). Only problem was changing one wire on the plug for the low voltage dc for the PC board. The unit would FM on 2m SSB; however, a new zener diode and more suitable crystal (factory-installed at no charge) took care of it. I even power a little 2m preamp from this line.

Paul Schuett WA6CPP
14472 Davis Road
Lodi CA 95240

Boos and Hisses

Dear Wayne:

I take umbrage to W4NVK's article in the December 73. I have yet to align or service any piece of ham equipment that I could not get at least 50 dB suppression of the carrier. Second, there is no way, under any circumstance, that bias shift on finals can cause an increase of carrier content on the signal. For the edification of Mr. Dusina, the author, I service and repair amateur goodies in the Detroit area. My operating bench is loaded with about $4,000.00 worth of equipment. I paid for these items by repairing equipment for 11 meter operators with General class or higher licenses. Only last Sunday, a fellow brought his transmitter over because he could get only 40 dB of suppression and while I checked, he yakked about how many years he was operating and no sense doing this or that to his rig, etc. While he talked, I removed 22 more dB of carrier from his set and $35.00 from his wallet. Anyway, if Mr. Dusina will ship prepaid his bucket of bolts to me, I'll remove his residual carrier free of charge. Otherwise, let him properly center the audio in the bandpass (then a $2.00 mike won't sound so good) and put an rf probe on the antenna output jack–lo and behold, he will have 60 dB of suppression. Next, his remark that a 100W CW signal is 200W SSB is erroneous. *A transmitter cannot put out more power than it has been loaded for without doubling plate voltage.* If you don't believe that, load your transmitter fully on CW, and with a scope, note the height of the solid rf display. Switch to SSB and the peaks will not exceed the CW.

Paul Kirsch WA8ASQ
14158 Foch
Livonia MI 48154

(Continued on page 128)



Part IV-The Terrible Jar At Leyden

The year was 1745, and scientific circles were all agog over that strange force called electricity. In England, several decades earlier, Francis Hawksbee had built an electric machine which produced unprecedented quantities of this mysterious power, and Stephen Gray had demonstrated that the power could actually flow from one substance to another. Two Frenchmen, Francois de Cisternay Dufay and Abbé Nollet had discovered two different kinds of electrical power, each capable of neutralizing the other.

Many theories had been offered as to the nature of electricity. The most popular was that it was some kind of an invisible fluid. (That's why we refer to it today as "juice.") All in all it certainly was an exciting time.

Leyden is a small town in Holland, about fifteen miles north of Rotterdam. It was there, during these exciting times, that a distinguished scientist, van Musschenbroek set out to find a way to collect this electric fluid. Could it possibly be collected in a bottle? With the aid of a pupil named Cuneus, van Musschenbroek connected his Hawksbee electric generator through an iron chain to a gun barrel. Another chain hung from the other end of the gun barrel. Van Musschenbroek had his student hold a jar so that the loose chain dangled into it. After the machine had run for a while, the jar was found to have an electric charge, but there was no fluid present. Van Musschenbroek then decided to put some water into the jar. He knew that electric fluid seemed to flow most easily through wet materials.

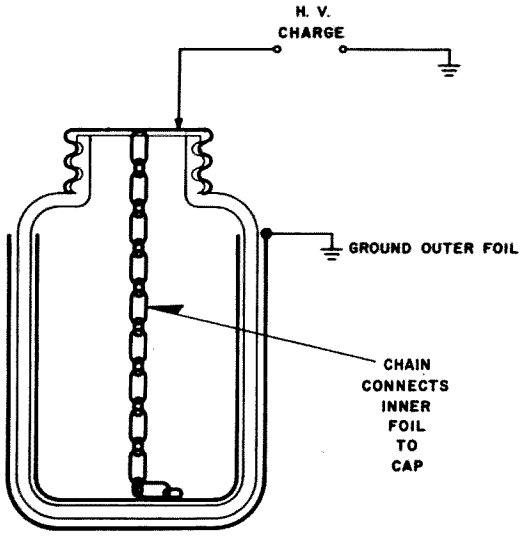
Soon they were set up and the machine was running again. Cuneus held the bottle at one end while the professor turned the generator. This time they carefully watched the level of the water, hoping to see evidence of more fluid. Time passed, and the liquid level in the jar was unchanged. The experimenters were discouraged. Van Musschenbroek stopped the machine, and Cuneus reached up to disconnect the chain.

Suddenly Cuneus dropped the jar and seemed almost to fly backward. The professor rushed over to his student. Cuneus was pale and scarcely breathing. He had received a shock such as no man had ever felt before. After his student recovered, Musschenbroek wrote of his "terrible" experiment to a colleague at the French Academy. He advised that no one else try it. Naturally, everyone else did.

At the same time as van Musschenbroek performed this nearly fatal experiment, the Bishop of Pomerania, E. G. von Kleist did essentially the same thing with similar results. He failed to publish his findings through acceptable channels, that is, by writing of them to a university or other seat of learning, so the credit went to Musschenbroek. The device was named the "Leyden Jar."

The scientists didn't realize it at the time,

but they had actually made a capacitor. The water served as one conductor and the student's hand as the other. The glass was the dielectric. It was later to be improved by using foil conductors, but in the meantime the water was thought to be essential. The scientists believed that the cool water condensed the electric fluid, and the Leyden Jar was nicknamed a "condenser." That term is still used to this day.

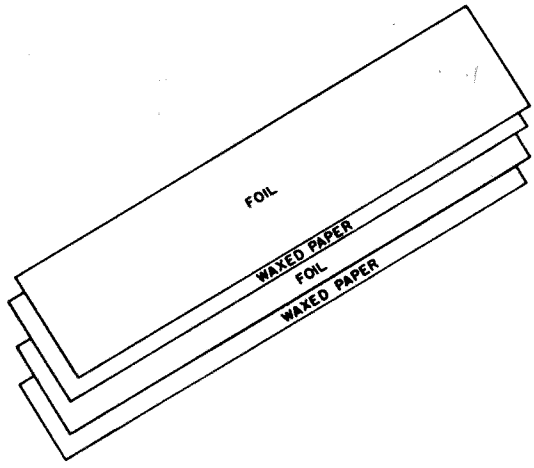


The home experimenter can make his own Leyden Jar quite easily. All that is needed is a peanut-butter jar, some aluminum foil, and a small length of chain. The inside and outside of the jar are lined with foil up to within ½-inch of the top. The chain is soldered to the center of the cover, and hangs down into the jar. It should be long enough that a couple of inches rests on the foil on the bottom.

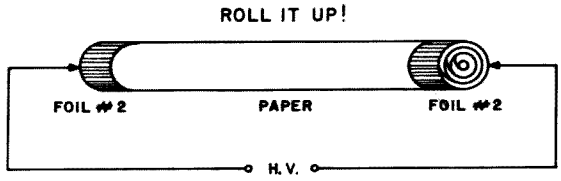
To charge your Leyden Jar, the outside foil should be grounded. You can use a battery, high voltage supply, or you can charge it up by static electricity. Simply rub a glass rod with a piece of silk and touch the rod to the cover of the jar. If you do this enough times, the jar will accumulate quite a charge.

Now, since some clod might be stupid enough to try it, *don't* connect it to a lightning rod. The early scientists who tried that seldom lived long enough to publish their results.

I once made a capacitor to demonstrate the principle to a group of Boy Scouts, using a roll of waxed paper and a roll or two of aluminum foil. Begin by unrolling four or five yards of waxed paper onto the floor. Place a strip of aluminum foil on top of this so that the foil overlaps the paper by a few

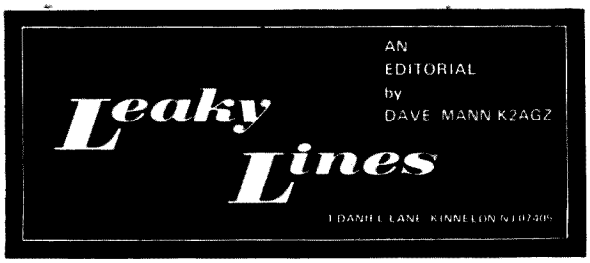


inches on one side, and the paper sticks out an inch or so on the other side. Lay a strip of waxed paper on top of this, exactly covering the first. You now should have a sandwich with the foil in the middle, one edge sticking out. Lay another strip of foil over this whole thing, but protruding on the other edge. The ends of the waxed paper should stick out far enough that the pieces of foil do not touch. Roll the whole mess up



as tight as you can. If you do it right, you'll have a fairly good capacitor. It should take a charge up to 100 volts or so. Mine broke down at 150.

. . . W2FEZ ■



Ever since that time a few months ago, when I wrote, "the handle here is Ignatz. . .Idiot, Garbage, Nuts, Alimony, Termite, Zilch. . ." I have been swamped with unsolicited examples of this outrageous phonetic claptrap. It seems that everyone has a favorite set of phonetics which he wishes to bequeath to a breathlessly waiting world. . .you know the type of stuff. . ."Floyd; Funny Little Old Yellow Dog." And. . ."WA2IWS; We Are Two Indians With Scurvy," and all that sort of penny-dreadful nonsense. The more farfetched it is, the more unfunny it becomes.

Now, as a chap who makes his living by putting words together, I warrant that if I desired to be a party to these grotesqueries, I could doubtless be very successful at it. But I think the thing is starting to get out of hand. We ought, really, to start clamping down on it. Unless it is a brilliant work of sparkling genius, I regard it as just sounding brass and a tinkling cymbal; and besides, it's beginning to fray my nerves.

Can you envision the result if this preposterous tripe is allowed to continue flourishing? Webster's Third New International includes over 450,000 entries, each of which is fair grist for the phonetic fetishist's mill. The possibilities are menacingly infinite! And, bear in mind, please, that's only one side of the problem; our own English language. How about all the others? There's Afro-Asiatic, Altaic, Indo-European, Macro-Khoisan, Malayo Polynesian, Indic, Luorawetlan, Niger-Congo, Sino-Tibetan, Uralic, Azteco-Tanoan, Hokan-Siouan, Macro-Chibchan and Penutian. . . . .a series of main linguistic stocks, covering some 700 different tongues, not counting regional dialects. Add to this the languages totally unrelated to any others; Basque, Andamanese, Ligurian, Yenisei-Ostyak. . .each of the 96 Australian aboriginal tongues, and all 132 of the Papuan languages, and perhaps you'll get an inkling of the utter incongruity and hopelessness of it all.

A long time ago I decided that the use of funny phonetics is not so much a method by which to clarify spellings as it is a display of other things altogether; would-be cleverness. . .sarcasm. . .and most of all, ego! The wildest flights into this adventurism and exhibitionism arise out of a profoundly felt need to assert the ego. Scratch the surface of the guy who gives his call as Willie Broke Four Plate Glass Windows, and underneath you are likely to discover an insecure, uncertain, indecisive, vacillating jerk with a pronounced inferiority complex, who is attempting to bolster his inward weaknesses by earning a reputation for great wit and brilliance.

Now please, I beg you. . .no more phonetics in the mail. I just can't take any more. However, if you're interested in some real clever ones, I just happen to have a few dillies. Just five bucks apiece; two for eight ninety-five; first come, first served. But, please keep it under your hat. I wouldn't want anyone to get the mistaken idea that my ego needs bolstering. Not a bit of it!

* * *

There is a situation which has arisen, and I'd like to throw it out to see what you all think about it.

A friend of mine who was a member of ARRL for many years, but who dropped his membership just before acquiring his Extra Class ticket, was in contact with another chap in the same boat. Both these boys are members of the highly vaunted A-1 Operators Club, and both are well seasoned, having a combined total of over 65 years of hamming under their belts. They are not given to shoddy operating habits, nor have I ever found them to be anything but considerate and courteous. From any point of view they are decent people.

Because they are not members of the League, they seldom read QST, and they were unaware that W1AW had changed its operating frequencies. This, despite opinions to the contrary, is neither here nor there. Even the membership of the League is not wholly aware that the frequencies have been changed.

Well, anyway, these two guys were in contact one evening on about 38.20. In the midst of a transmission, and without the slightest advance warning, in came the Official Bulletin from Newington. It wiped out the QSO as effectively as if the band had gone dead.

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Now, if WIAW is an amateur station, operating within the same restrictions as the rest of us, then why may they be excused when they commit a breach of courtesy toward other stations. We are all expected to observe the etiquette which the ARRL prescribes: to check the frequency before transmitting. Even if a net with a scheduled operating time discovers that its frequency is occupied, the SCM has the decency to request that the occupant QSY so that the net may operate on a clear channel. If the chap who is thus asked is a gentleman, and most of them are, he will most assuredly move. But, to come right on the frequency without even checking to see, seems to me to be the most arrogant and unwarranted type of rule-flouting in the book.

Since WIAW happens to be the League amateur station, I feel strongly that it should be operated in an exemplary fashion. There is no valid excuse for breaking this basic regulation. In fact, if some extenuating circumstance were to excuse an individual ham for doing this, WIAW should be operated so superlatively that the case would never have arisen. No station should break this rule. It is most distressing when the rule is circumvented by the Headquarters station.

When the bulletin was over, the operator signed the call and announced that the station was standing by for calls. My friend gave them a call and they came right back to him. He took issue with the operator, asking him why he had not checked the frequency before transmitting the text of the bulletin. The operator replied, "I can't comment about that. If you wish to complain, you may write to the League, and take it up with them."

Well, that's it. What do you feel about it? Do you think that WIAW, despite its undeniable help to amateurs, should have the right to ignore the good operating practices which we are all constantly enjoined to observe? I do not think so. But that's only my opinion. What's yours?

* * *

This isn't an original idea, of course. . . .I'm sure somebody must have proposed it. Why, if there's a thing called Operator of the Month, isn't it feasible to publish a list called Lid of the Month? Some of the characters on the ham bands really do deserve this sort of publicity, as you will undoubtedly agree. It's just too bad that the most iniquitous ones invariably operate anonymously, so that it's difficult to identify them.

One thing is certain. If you would like to discourage the intrusions of unwelcome carrier throwers, burpers, whistlers, razzers, and other intruders, never. . . .but never, never comment openly about them. That's exactly what they want in the first place. So don't give them the satisfaction of successfully provoking you into an altercation on the air. If you ignore them, chances are that they will move off your frequency and seek someone else who might just rise to the bait.

Apropos of my recent rhymed diatribe against TV commercials, I recall with delicious amusement an incident of about six years ago.

My father, who had a marvelous admixture of bored cynicism and a highly sophisticated sense of humor, loathed and abominated TV commercials. One of these in particular used to offend him very much. There was an animated character with a head formed of a seltzer tablet. He sang a childish little jingle which ended with an advertising slogan for the product. You simply could not avoid this thing . . .it was like the plague; repetitious and redundant.

Dad got hold of an old mezzo-tint of Socrates, drinking the cup of hemlock. In bold letters, and with a red marking pen, he inscribed it, and sent it to the advertising agency which handled the account. His inscription read, simply, "RELIEF IS JUST A SWALLOW AWAY."

* * *

I'd like to discuss an event which rankles in the breast of almost every amateur even now, several years afterward. I refer, of course, to the removal of 27 MHz from the amateur spectrum, and its reassignment and deterioration into the monstrosity and misbegotten mishmash it was inevitably to become.

Most of us have to take a position. We cannot blow hot and cold with the same breath. We cannot plant both feet firmly in mid-air. Yet, there are those who pretend to be the champions of both contending forces, both unalterably in opposition to each other. . . .both of whose interests lie clearly in diametrically opposite directions.

Can you imagine a man playing both sides of a chessboard? Can you conceive of one general acting as strategist for two warring armies? Can you picture one attorney representing both plaintiff and defendant in a lawsuit? And, if such a lawyer were to advise you to act in such and such a manner, would you be expected to follow his advocacy with implicit faith and confidence? I think not. You would be most imprudent, if you did.

A certain publishing company issues two magazines; one for hams; the other for CB'ers. Now this, in and of itself, is certainly no sin. It is perfectly possible to serve the interests of both, SO LONG AS THEY DO NOT ATTEMPT TO GAIN AN ADVANTAGE FOR ONE, AT THE EXPENSE OF THE OTHER. Through the years, however, in the pages of CQ Magazine, we have seen hints, outlines, draughts, suggestions, proposals, resolutions, and motions, all calling for the creation of additional frequencies for Citizens' Band. They have called for the implementation of a new class of amateur license which would open up the ham ranks to CB'ers, (as if the doors were closed to them now). There is a persistent subterfuge—a nice little fiction—that these people constitute a pool of potential amateur operators, the encouragement of whom all will ultimately supplement our growth, and make us strong and healthy. In other words. . . "Let's have this teentsy-weentsy slice of 10 meters, fellows. You're not using it anyway. Let's allow these nice, deserving folks to use it so that they can develop their skill and talent. They are really different than you think, way down deep inside. They are serious, earnest, purposeful and dedicated, and we owe them an opportunity to develop these splendid and sterling qualities so that they may take their rightful place beside us as full-fledged amateurs.

Now, really, I ask in all candor. . .is there a single ham who has the slightest inclination to take this stuff seriously? I certainly hope not! The only quarter in which it might meet with approval is among the CB manufacturers.

Picture this fantasy. The moment these fine, misunderstood fellows are given these additional frequencies, they will instantly begin to observe all the FCC regulations. By some strange and miraculous atavism, they will become first-class operators. The only thing, you see, that keeps them from doing this right this very minute, is because the poor dears are all squeezed and squished into those horrid, little 23 channels. That's why they call skip, use VFOs, run high power, use illegal antennas, don't give proper callsigns, interfere intentionally, persist in the use of profanity and obscenity, and break all the other rules. But never you mind; the moment they are granted this allocation, they will change. They will become fine, law-abiding members of the ham fraternity, and dedicate themselves to constructive purposes. They will be a credit to us all. Just do away with the nasty old code and theory requirements. . . please . . .pretty please . . .and you'll be surprised at how they'll change.

I'm not anxious to pillory CQ. I have some very good friends there—people for whom I have the utmost regard. But I can't help feeling that the front office allowed its "druthers" to be seen in public print, in spite of—not because of—these nice people. And I think that we hams ought to express our united opposition to all such plans, though they may sound ever so lofty and constructive. They can have but one result. . .the weakening of amateur radio. And there has never been a time in our history when we needed so badly to maintain all the strength we can muster.

* * *

A few weeks ago it was decided that I would lie "doggo" on the subject of the League for a while. Wayne felt, and I agreed with him, that there would be no point in continuing to take issue with certain aspects, since I had already expressed most of the reasons for my objections, and had given voice to many of the sentiments unexpressed by the common, garden-type variety of ham, which deserved to be articulated. I fully intended to concern myself with other matters which would be of interest to the readership. But I find that I cannot seem to get away from these issues, after all. The latest issue of QST includes a League proposal, which, if advanced to FCC as it is now proposed, can possibly be even more dangerous than any other ARRL-sponsored change within memory, including incentive licensing.

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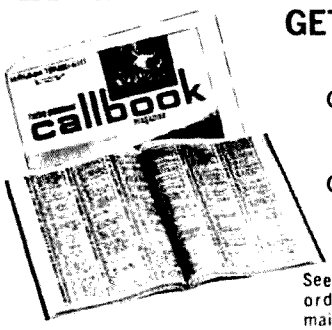
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At this point, allow me to emphasize unequivocally that I have absolutely no prejudice against those who hold Technician grade licenses. If I do object to any of them, it is on the ground that *some* of them operate in violation of the spirit, if not the letter of the FCC regulations. Many of them, probably a majority, conduct themselves conscientiously, but it is simply impossible to ignore the infantile antics of the violators among them. This is not to say that there are no culprits among other classes of amateurs. But the reasons are not the same. In my judgment, one of the important reasons for the misbehavior of certain individuals among Techs, is that they obtained their licenses fraudulently to begin with. Many well-meaning operators, acting in the prescribed role of volunteer examiners, and probably in a spirit of overpermissiveness, have given an inordinate measure of assistance to applicants for the Tech ticket. In some cases the CW requirements were completely bypassed. In other cases the examiner rendered illegal aid on the written portions of the examinations. In this fashion a group of persons who were never really interested in conforming to the stated purpose of this particular grade of license, but who were merely desirous of pursuing the communications end of the hobby, were permitted to infiltrate the ranks of the Technicians. They became figuratively and literally marooned in that category, because there were but few avenues through which they might upgrade their skills in order to meet the standard requirements for the other grades. There have been Techs, of course, who buckled down to work, and developed their code speed. But, on the whole, they did not seem to care too much about becoming General class operators, being content, rather, with staying in their own special niche.

There is no point beating about the bush. You have heard, as I have, the expression "mail-order license" used over and over again. There is no doubt that a sizable segment of those who hold this ticket earned it as a result of less than fastidious observance of the rules by the volunteer examiners. And this practice, though it might appear to be negligible in actual numbers, has tended to lower standards for entire group.

Now ARRL has decided to propose that Techs be permitted phone and other privileges between 29.5 and 29.7 MHz. There is no mention of any qualifying examination for this additional privilege. And I believe that each and every ham who had to go and upgrade his ticket in order to continue to operate, not on newly granted frequencies, but on the same frequencies where he had previously been entitled to do so, should be raising his or her voice in protest. It may be perfectly true that this particular slice of the spectrum is not overused. It may be lying completely fallow. But this fact should not constitute justification for cheapening or vulgarizing it in this fashion.

I say, compel all Technicians who wish to avail themselves of this or any additional privilege to submit to a proper examination in the presence of an official FCC examiner. Those Techs who wish to get this additional slice of the spectrum should be, and undoubtedly will be, in my view, willing to buckle

down, as did the rest of us in similar circumstances. This privilege, if offered at all, should not be a free gift, but an incentive. If the League truly believes that incentives will really upgrade the quality of amateur operations, then it *must not* allow this concept to be torpedoed with an inconsistent approach toward one segment of the ham population! If the League is thinking that it will gain membership as a result of a huge and enthusiastic influx of grateful Techs, responding to this magnanimous gesture on the part of Newington, let them contemplate the wholesale hegira from the ranks by thousands of members, already disenchanged with the way things have been going. For every grateful Tech who joins ARRL, I believe there will be a score of members of long standing who will simply quit in disgust.

I am very unhappy with this proposal. I would be much more unhappy if I thought that my fellow amateurs would allow this proposal to go through without a mighty outcry of dissent. If we do not yammer to our directors and to the League executives about this injustice, we will not have the right to complain about it afterward! Nor would we deserve that right.

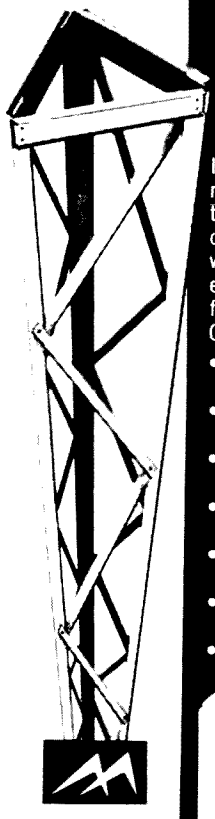
Here is a golden opportunity for us to test the League's willingness to be responsive to the desires and needs of its members. Typically, of course, in its time-hallowed attitude of paternalism, the League will tell us that it knows what is best for us. Is there anyone left who actually believes this? Is there any soul who has observed the debacle of the unused sub-bands, and the horrendous congestion in the unrestricted portions, who can be gullible enough to buy this ancient and worn-out canard?

I would be very much surprised if this atrocious proposal should meet with the approval of the majority of the amateurs. Since it would result in an advantage to some, gained through preferential bias for this one license grade, it spells a disadvantage, in effect, for all the rest of us.

Let us all make certain that we express our feelings on the question. Let no amateur fail to communicate with ARRL and its leaders, so that we may avoid a perilous situation in future years. This proposal constitutes a dangerous precedent. It would enable some FCC, as yet unnamed, perhaps, to reassign portions of our bands to whomever it wishes, on the simple ground that it is right to exact standards of ability from some, while permitting others to ignore any standards whatsoever! It would also establish that frequencies which are not widely utilized may be preempted by groups which might make more use of them. On this basis it would be possible to witness a gradual attrition of the entire amateur spectrum, through their reassignment to anyone or any group with sufficient influence to convince or mislead the Commission.

Please, I entreat you with all earnestness and sincerity, do not let this proposal get to first base. This could be the most important decision you can make during your entire amateur life. Don't let it get through, especially by default. Write, wire, and call your director. Do it today!!!!

. . . Dave Mann K2AGZ■



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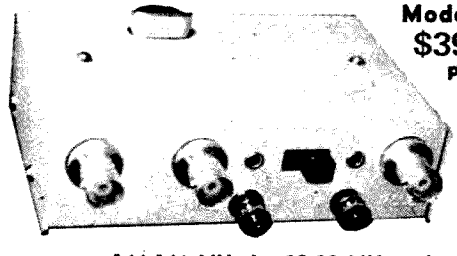
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Emergency Net Changes Name, Frequency

MEDINET—Medical Information Network—is the new name of the Public Health Service Emergency Radio Network, the Secretary of Health, Education, and Welfare announced today. The network was organized a year ago by the Division of Emergency Health Services, Health Services and Mental Health Administration, to provide communication during health emergencies when downed telephone lines have closed normal communication channels.

MEDINET is made up of employees of the Department of Health, Education, and Welfare (HEW) who live outside the Washington, D.C. metropolitan area and who are licensed amateur radio operators, or "hams." MEDINET's most vital function is to provide rapid communication among health officials at the local, state and federal levels during disasters. When normal communications channels are closed, MEDINET steps in to insure the fastest possible response to the health needs of disaster areas. Participation in MEDINET is voluntary. It is undertaken as a public service by the HEW employees involved. When an emergency occurs, MEDINET members are excused from their normal duties so that they can participate in the network. Network control for MEDINET is provided by the National Institutes of Health Radio Amateur Club station, K3YGG, at Bethesda, Maryland, a Washington, D.C. suburb.

The change of name, from PHS Emergency Radio Network to MEDINET, will permit routine on-the-air meetings of the network's members without any Federal connotation. To promote the use of a single frequency by all medically oriented networks—such as the Medical Amateur Radio Council, Ltd., an organization of physician hams—MEDINET's frequencies were recently changed to 7260 kHz and 14280 kHz (with 21360 kHz as an alternate).

Presently, MEDINET is meeting on the air every Monday at 12:00 noon and every Wednesday at 5:00 p.m. Eastern Time. MEDINET Control, K3YGG, operates at 20 meters on 14280 kHz and 40 meters on 7260 kHz simultaneously at these times.

A few of the MEDINET members do not have transmitters powerful enough to communicate directly with Washington, D.C. MEDINET, however, is set up so that it can relay messages from station to station across the continent. This technique was used with dramatic success in the recent Hurricane Camille disaster on the Gulf coast.

Announcement

12th Annual Dinner

The East Coast VHF Society's 12th annual dinner will be held Saturday, March 21, 1970, at the Neptune Inn, Route 4, Paramus, N.J., starting at 7 p.m. Ted Mathewson W4FJ will talk on "VHF—Past, Present, and Future." Awards will be given by Ed Tilton W1HDQ, including awards for highest single and multioperator station in the September VHF contest. The menu will be prime ribs of beef and tickets will be sold for $7.50. Group reservations are available in blocks of 5 to 10. Ticket deadline is Wednesday, March 11. For tickets and reservations write the East Coast VHF Society (WA2WEB), PO Box 1263, Paterson NJ 07509.

Amateur Radio

AMATEUR RADIO IN INDIA

Marie Welsh W6JEP
Reprinted from LERC Bulletin

G. V. Sulu (VU2GV) was kind enough to send a copy of the Radio & Electronics Society of India (RESI) Book Series 1 Amateur Radio Regulations in India, compiled by M. V. Kini (VU2SZ). This 1968 First Edition is very interesting and our readers may appreciate the following highlights which I've extracted from the book:

1. No 160 or 6 meter privileges.
2. 10 kHz only on 80 meters; 3890-3900 kHz.
3. 100 kHz only on 40 meters; 7.0-7.1 MHz.
4. 20, 15, and 10 meters are the same as our bands.
5. 2 meter band is 144-146 MHz.
6. 420-450 MHz also used by radio altimeters.
7. 1215-1300 MHz shared with fixed and mobile services.
8. 2300-2450 MHz primarily assigned to fixed, mobile, and radio location services. 2450 MHz shared with Industry, Medicine, and Scientific groups.
9. 3300-3500 MHz shared with fixed and mobile services.
10. 5650-5850 MHz shared with fixed and mobile services; 5800 MHz is for industry, medical, and scientific purposes.
11. 10.000-10.500 GHz and 21-22 GHz are used as ham bands.
12. The top license is called Grade I. This ticket is available to those who are 16 or older. The code test is at 12 wpm and the theory test is about the same as our Novice exam.
13. The other license is called Grade II. This ticket is available to those 14 or older. The code test is at 5 wpm and the theory test is 25% easier than the Grade I exam.
14. The maximum input power for SSB operation has been increased from 100 to 400W PEP.
15. Mobile operation is now authorized on the VHF bands.
16. There are about 500 licensed hams in India, and the majority of them are quite new to the hobby.
17. Ham literature is very scarce in India and ordinary electronic components are just about nonexistent.
18. Amateur licensing exams are conducted (by appointment only) at 5 monitoring stations of the Department of Communications and Civil Aviation with requests addressed to the Wireless Adviser, Wireless Planning and Coordination, Ministry of Transport and Communication.
19. The Grade I exam fee is 10 rupees and the Grade II fee is 5 rupees.
20. Grade I station applications cost 15 rupees and Grade II ones cost 10 rupees.
21. Grade I licenses will soon be renewable for 3 years at 42 rupees.
22. Grade II licenses are not renewable after 3 years; the holder must upgrade to Grade I or lose his license.
23. Ham licenses can be granted to nationals of other countries.
24. Station particulars must be detailed on the

News Page

station application. If not commercial or surplus equipment, a diagram of the transmitter must be attached. Receiver details must be attached. A sketch of the antenna (showing dimensions and mechanical supports) must be included.

25. The powers at the (1) power supply, (2) final amplifier input, and antenna input must be stated on the station application.
26. The desired transmitting and receiving frequencies must be stated on the station application.
27. The equipment frequency range capability must be stated on the station application.
28. Two passport-size photographs are required with the operator application.
29. The applicant's physical description and personal data are required on the operator's application.

FCC Notes

CB Traffic Reporting Authorized

CB rules (Section 95.83(a) (14) have been amended to permit licensees to transmit information on highway conditions to persons or emergency organizations furnishing such information to the motoring public by way of radio broadcast facilities (Docket 18625; RM-1388). The amendment will provide for road information furnished by a CB radio station to be compiled and edited by the broadcaster and then announced over a broadcast facility.

40 Meter Segment Opens for Ham Band Marine Operation

Amendment of the amateur service rules Section 97.95(b) (2) concerning maritime mobile operation permits United States amateurs, when outside the jurisdiction of a foreign government, to operate in the 7.0-7.1 MHz band in areas of Europe, Africa, and Northern Asia (Region 1) and Southern Asia and Oceania (Region 3), effective December 31, 1969. The 40 meter frequencies from 7 to 7.1 MHz have been allocated for exclusive use of the amateur radio service on a worldwide basis.

Fort Sill Fest

The annual Fort Sill hamfest will take place in Lawton, Oklahoma on February 22. For details, write Lawton—Fort Sill ARC, Box 892, Lawton OK 73501.

Storm Warning

In the March 1969 issue of Popular Science there was an interesting article explaining the Newton Weller system of using your TV set as a tornado warning device. The mechanics are simple:

- Tune your TV set to channel 13
- Turn the brightness control until the screen is dark
- Tune to channel 2

If the screen is white, then there is a tornado nearby. White streaks on the screen are an indication of lightning activity. A dark screen shows there are no electrical storms in the area. If there is a local station on channel 2, you may see its picture instead of a blank screen.

Newton Weller found that tornados have an oscillating electrical field around the eye. The frequency of this oscillating field is very close to 55 MHz (that is, channel 2). One darkens the screen while tuned to channel 13 to give a reference as far from 55 MHz as possible. The high signal level produced by the tornado or electrical storm is enough to turn the screen white on channel 2.

. . . WA6YZD, as lifted from the Sacramento Club paper

Blossomland Annual Auction

The 3rd Annual Blossomland Amateur Radio Auction will be held March 15, 1970 at the Youth Memorial Building, Berrien County Fairgrounds, one mile north-west of Berrien Springs, Michigan.

Last year over 300 amateurs turned out for Southwestern Michigan's fastest growing ham event, and went home with carloads of fine gear (or money). The 1970 auction promises to be bigger and better.

Acres of free parking will be available for the trailerloads of bargains that will no doubt show up. Don't pack a lunch. . .hot food will be available. Prefer to do your own selling? Rent one of the swap tables. If that fails, a skilled auctioneer will put your gear on the block.

One happy ham went away with a Heathkit Hotwater 100—the grand prize last year. A lot of others won smaller items. What will this year's door prizes be? Be there March 15 and find out.

Coming from out of town? Just get on US 31-33 to the Fairgrounds north of Berrien Springs. Running mobile on 75 or 2? Direction service and call-in on 3925 or 146.94 FM.

Check your shack now. . .and be at the auction between 10 a.m. and 1 p.m. (starting time) to convert that old gear into something easier to carry. . .money.

OLD TIMERS



The "Old Timers Dinner" for the Southeast U.S. sponsored by the Birmingham Amateur Radio Club will be held at 7:30 p.m., February 14, at the Holiday Inn East (Highway 78 East). Leland Smith, W4AGI/W5KL, will be the featured speaker.

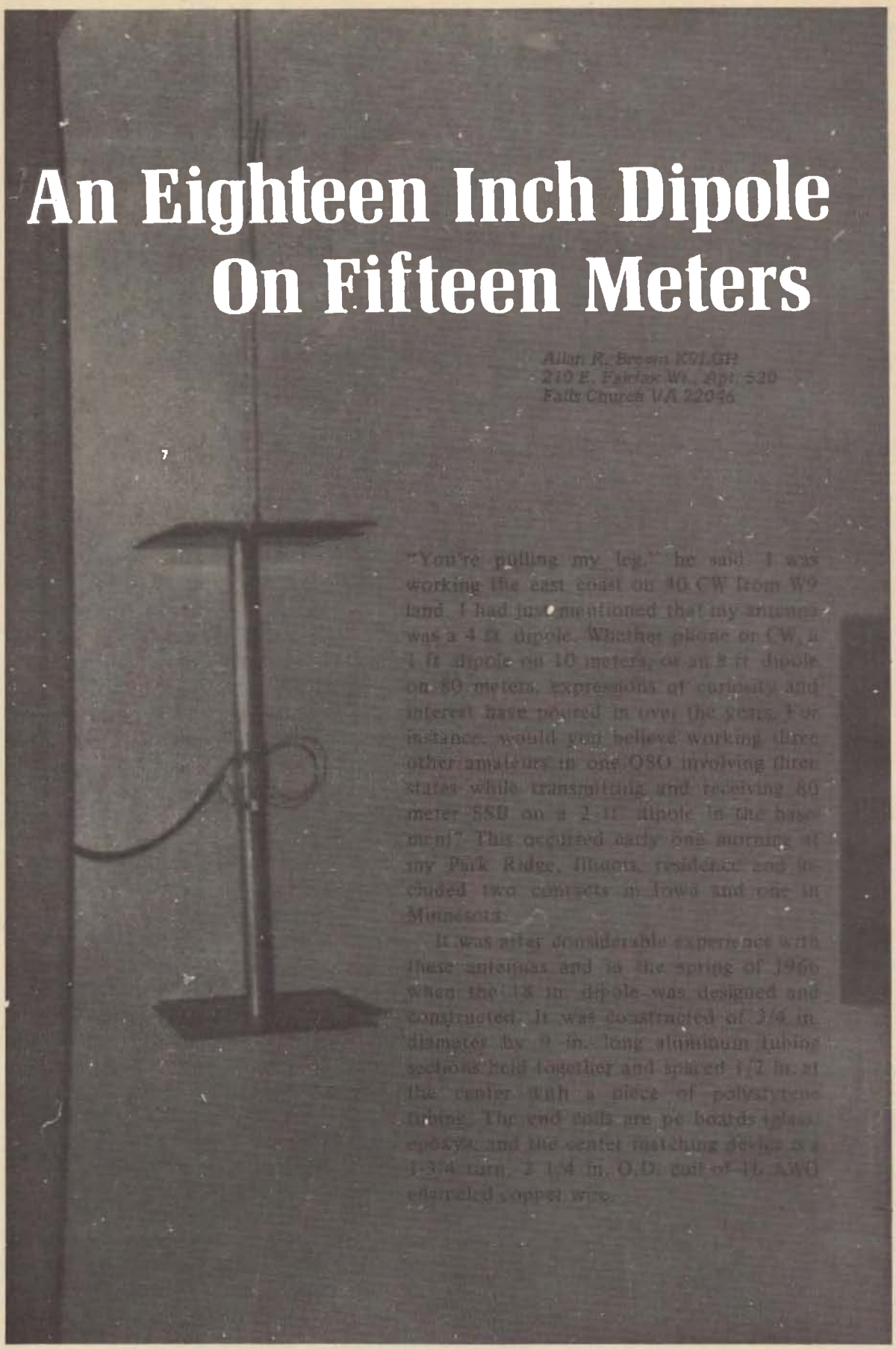
This appears to be an annual event, predicated on the tremendous crowd attending last year. A license issued before 1930 entitles a ham and his wife to a free dinner.

Antique equipment, magazines and "hams" will be on display.

For further information contact W4GET or W4AXL, Box 603, Birmingham AL.

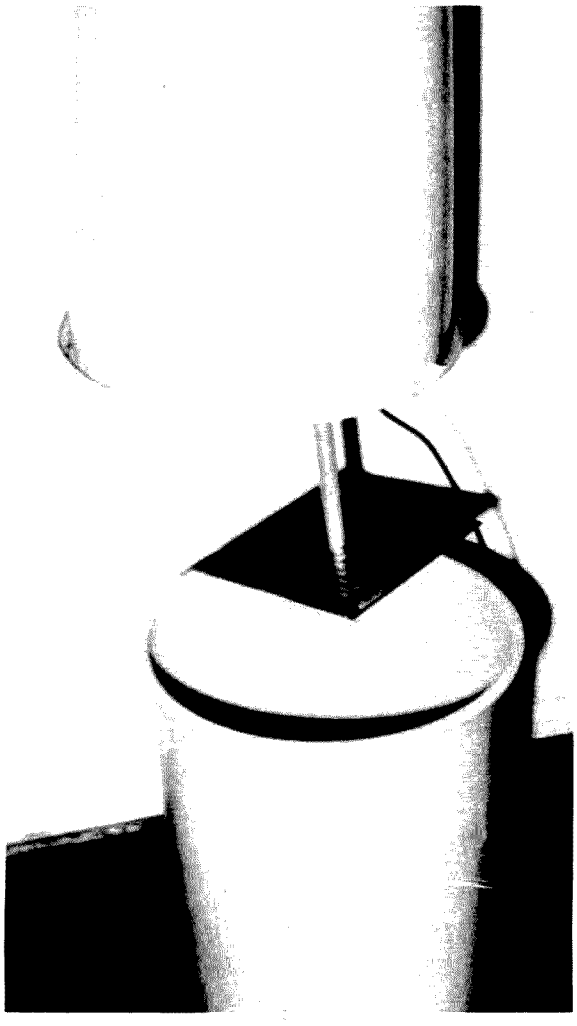
An Eighteen Inch Dipole On Fifteen Meters

Allan R. Breem K9LGH
210 E. Fairfax Wt., Apt. 520
Falls Church VA 22046



"You're pulling my leg," he said. I was working the east coast on 40 CW from W9 land. I had just mentioned that my antenna was a 4 ft. dipole. Whether phone or CW, a 3 ft dipole on 10 meters, or an 8 ft dipole on 80 meters, expressions of curiosity and interest have poured in over the years. For instance, would you believe working three other amateurs in one QSO involving three states while transmitting and receiving 80 meter SSB on a 2 ft. dipole in the basement? This occurred early one morning at my Park Ridge, Illinois, residence and included two contacts in Iowa and one in Minnesota.

It was after considerable experience with these antennas and in the spring of 1966 when the 18 in. dipole was designed and constructed. It was constructed of 3/4 in. diameter by 9 in. long aluminum tubing sections held together and spaced 1/2 in. at the center with a piece of polystyrene tubing. The end coils are pc boards (glass epoxy) and the center matching device is a 1-3/4 turn, 2 1/4 in. O.D. coil of #16 AWG enameled copper wire.



The circuit boards were hand painted with photoresist after first ruling the edges of the lines with a resist pen. Then the circuit boards were etched with ferric chloride. The ends of the straight dipole section were plugged, and the coils held in place with a single screw in each end. There is one left-hand and one right-hand coil, so that with the conducting sides of the coils turned toward each other, the currents in the coils oppose each other to reduce premature radiation.

The final touch is the tuning means, which consists of telescoping brass tubings (I obtained them from a local hobby shop). The inner tubing is 1/16 in. O.D. and the outer tubings are soldered to the ends of their respective coils.

This little antenna turned out to be my favorite, as it was inconspicuous and could be taken down and lost in a small piece of airplane luggage. Since it is matched to a 50 ohm coaxial cable (usually RG-58/U), all that is necessary is to connect it, tune it, and go on the air.

Good results were obtained from the outset with the antenna sitting on the nylon web of a lawn chair on the balcony. In the fall I hung it in two plastic wastebaskets, one inverted on top of the other; there it sat all winter long bringing in the contacts. The maximum power used was provided by four 1625 tubes in a homebrew grounded-grid linear. Estimated input is 300W PEP with additional feedthrough from the exciter. That power level is about the limit for the printed circuit coils.

These antennas have been a real fun thing, from the very first successful model—which was a 2 ft dipole on 40 meters. A prototype 4 ft antenna was made for 40 meters and a few were made and sold to test the market. There is presently no commercial product available, but a patent* has been granted on the antenna.

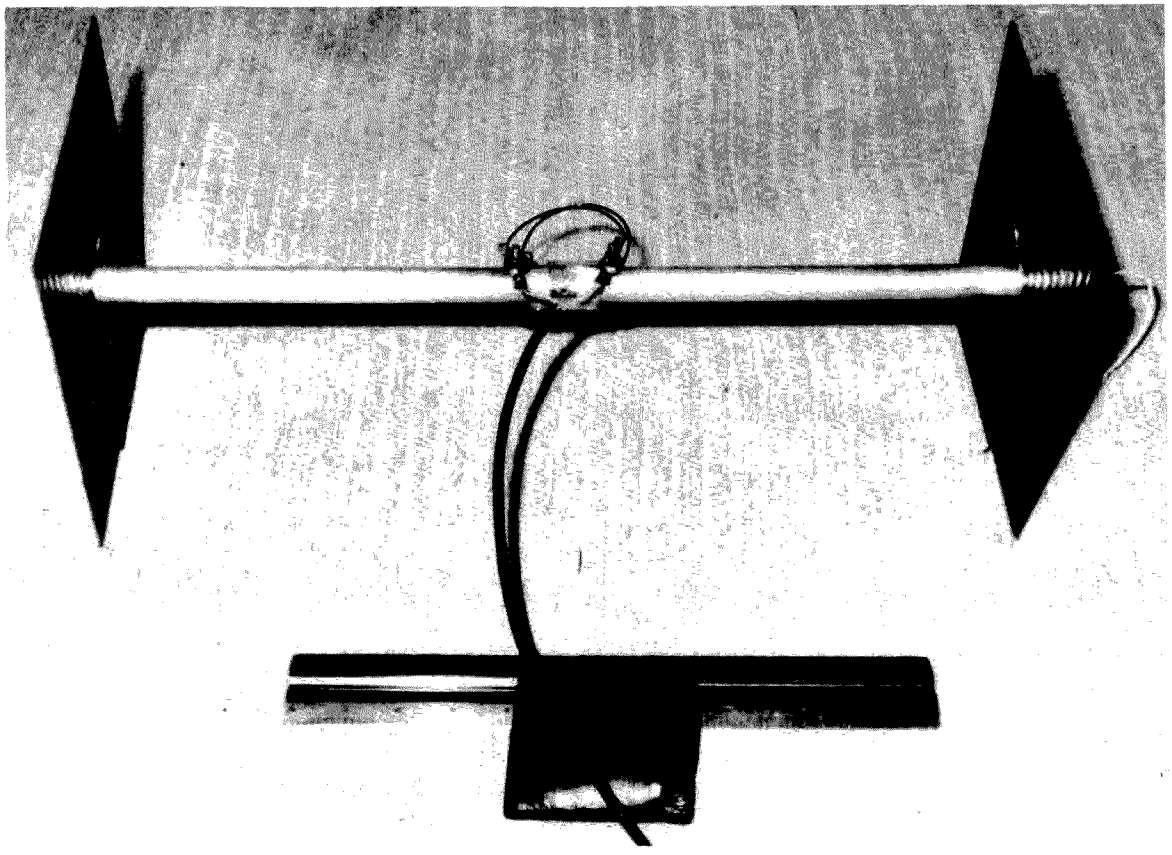
The antenna system comprises an end-loaded dipole with matching impedance in the center. The straight dipole has a high radiating efficiency, and there is undoubtedly a substantial contribution from the strong electrical dipole produced by the two end coils which are opposed magnetically. This accomplishes two things:

1. Radiation at right angles to the principal field of the straight dipole is reduced or nearly eliminated.

2. Radiation off the ends is also greatly reduced, thus avoiding or reducing losses which might otherwise occur through coupling with nearby lossy objects.

Although a highly efficient antenna should be possible in this configuration, the efforts have been concentrated on making small lightweight antennas, for economy, ease of handling, and with minimum space requirements. The actual efficiencies would be very difficult to calculate since the distribution of the current in the coils is a

*Patent No. 3,432,858 owned by the author. The author does not object to having amateurs build these antennas exclusively for their own experimental use.



The keycase and ruler are shown beside the 18 in. 15 meter dipole for size comparison. A string attached to a clamp under the screw on one end permits hanging the antenna from a convenient support. One word of caution: the coax must be kept several inches away from the coil edges to avoid a detuning effect.

complex phenomenon. However, with antennas, performance is the prime criterion—and this has proved very gratifying; the antennas have been tested and used by several of the author's friends with consistently good results.

One of the greatest advantages of the antenna is its small size and weight which permit it to be placed more favorably at times than such antennas as the ground-based vertical or a half-wave dipole. Taking advantage of its size and independence from the ground, it can be placed at an optimum height for the desired angle of radiation. Or it can be used either horizontally or vertically to achieve optimum propagation over short or long hauls. For example, the 4 ft 40 meter dipole worked very well vertically for the long hauls, but better horizontally for distances of 60 to 100 miles.

The advantage of raising the antenna to an optimum height, which for longer skips may be one-half to one wavelength above the ground, may be seen from the graphs contained in an article by W. H. Anderson VE3AAZ (Antenna Behavior Over Real Earth, QST, June 1965, pages 61-64). The 9 ft 40 meter antenna weighed 3 1/2 pounds and thus could be placed on a light support anywhere on the house or other structure where a little free space was available. Thus in a vertical position at some height above the ground, it might perform as well, or better, than a quarter-wave ground-based vertical. As seen from the above, there is no reason why the antenna cannot be mounted horizontally and rotated. This, of course, has been done, and although the tests made were not extensive, it was found that the short dipole (4 ft on 40 and 8 ft on 80 meters have been tried this way) behaved directionally about like a half-wave dipole.

Very good results have been achieved with the 40 meter dipole in the vertical position at a height of 25 ft. Africa and Ireland were worked from the W9 location with this arrangement. However, one thing

was learned with the 40 meter antenna on the top of a telescoping steel pole. The base of the pole was on the ground, and when the ground was wet and the pole extended to a quarter-wavelength, the pole started resonating and changed the radiating resistance of the short dipole and, consequently, the vswr which is normally kept low (1:1 at the center-tuned frequency in the vertical position when optimum adjustment is achieved).

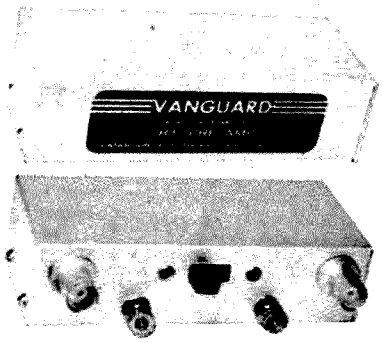
The experience with the radiating support, of course, is indicative of what can happen with any portable antenna. It is subject to variations in characteristics when brought near other objects with nearly the same frequency of resonance. When the lower end of the telescoping steel pole was insulated from the ground, it was possible to extend it to any height (within its 40 ft capacity) without changing the tuning of the antenna. Of course, this was with the antenna in the vertical position. With the short dipole in the horizontal position, it could be expected to change its characteristics as its height was changed due to imaging in the ground.

The possibilities of experimenting with antenna height vs propagation effects on the 40 and 80 meter bands with small lightweight antennas of this type are excellent since they require only lightweight supports and may be easily mounted in either the horizontal or vertical positions down to a very small fraction of a wavelength from the ground. The 40 meter dipole worked very well 6 ft above the ground and could undoubtedly be used even lower. This was in the vertical position which, with a half-wave dipole, would put the current node 40 ft off the ground (instead of 8 ft). In the horizontal mode, both the 4 ft antennas on 40 meters and the 8 ft antenna on 80 meters have been mounted directly to a steel mast with right-angle clamps with good results. The clamps were placed close to the center of the straight dipole section and on the same side to which the coax shield was connected.

One of the first questions asked is whether multiband operation is possible with these short dipole antennas. First, the antennas may be tuned to the odd harmonics of the fundamental frequency of the

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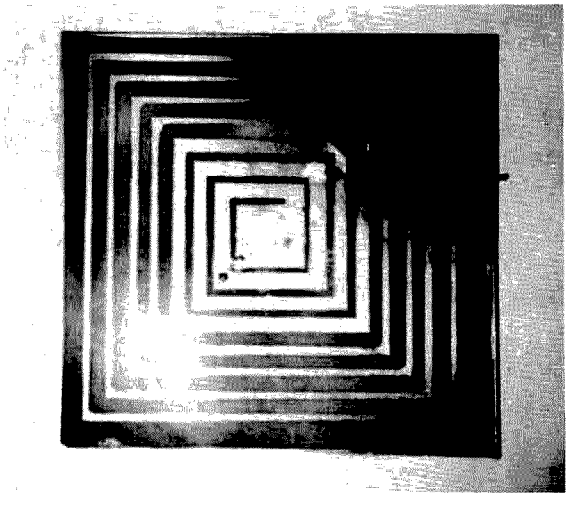
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antenna. Thus, the 4 ft dipole for 40 meters worked very well on 15 meters. One 2 ft dipole for 15 meters and 20 meters tuned to a low vswr on 6 meters.

The 2 ft dipole for 15 and 20 meters contained a trap in each coil to permit operation on the two bands. Fine adjustment in both bands was accomplished by adjusting taps on the inside turns of the end loading coils. The coils tune sharply, much like mobile antennas, as the radiating resistance is low and the overall Q of the antenna is high. It was found that with the 18 in. dipole for 15 meters, the entire phone band could be tuned with my SBE Model 34 transceiver. However, the 4 ft dipole required adjustment to cover the entire phone band on 40 meters, as when tuned 1:1 at the center of the phone band, the vswr at 7.2 and 7.3 MHz was about 3:1. An experimental remote tuning device with a reversible motor was built and operated on 40 meters. This device permitted tuning right "on the button" on both 40 and 15 meters.



The coil dimensions for 15 meters are 7-3/8 by 7-3/4 in., and the turns are purposely made wider in the center where the current is higher. The inner conductor (first turn) is 1/4 in. wide, and the next two graduations in conductor width are supposed to be 3/16 and 1/8 in. respectively. On the left side may be seen the tuning stub, which is a 1/16 in. O.D. brass tube which slides in a larger tubing. The larger diameter tubing is soldered to the end of the printed circuit coil.

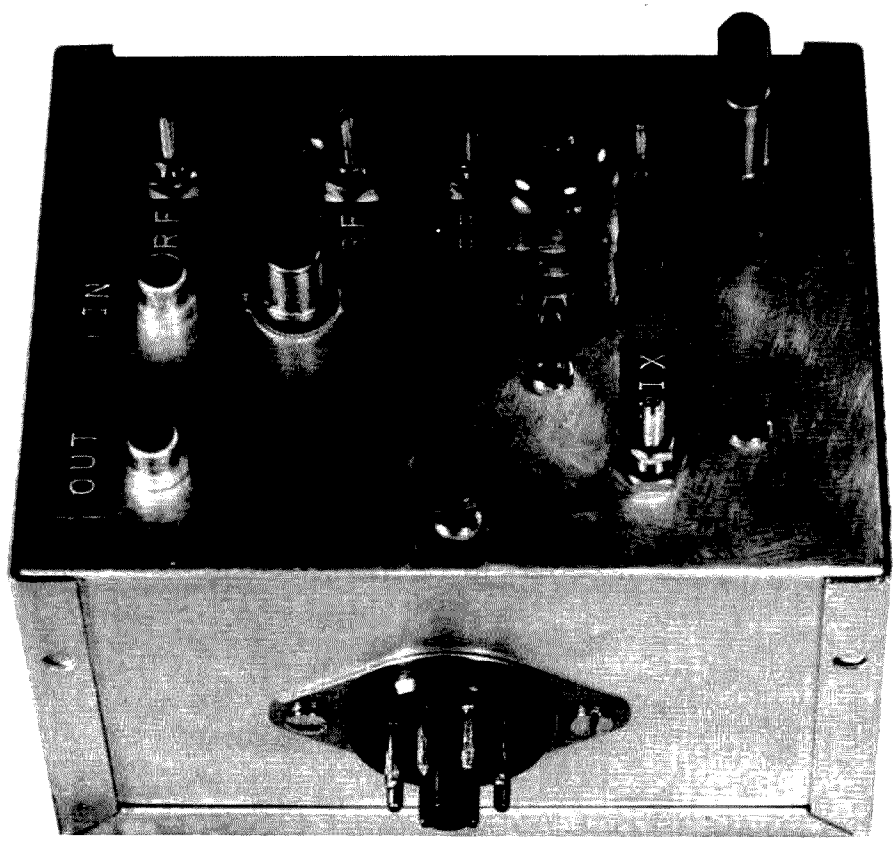
Three 4 ft dipoles were wide-spaced 6 ft above the ground to form a beam. As they were fixed and could not be rotated, the direction of the beam was changed by running out and quickly interchanging the director and reflector or front and back dipoles. The beam seemed to have a good front-to-back ratio, but the gain was not checked. It appears that two or three such dipoles on a boom might be great for 40 or 80 meters. They could be used as a rotatable beam either with horizontal or vertical polarization. This could be changed remotely by a motor drive, which should lead to some interesting experiments in propagation effects.

Tuning these antennas requires some type of instrumentation to determine optimum operating conditions. The minimum should include at least a vswr meter. The antennas should be tuned so that near zero or very low reflected power is in evidence. If the center matching impedance is proper, the only tuning required is to adjust the two coils until the antenna is resonant at the operating frequency. Then the vswr should be near 1:1. Initially, if the matching impedance is a little off, it may not be possible to bring the reflected power down near zero, but a low point will be found indicating resonance has been achieved. Increasing or decreasing the matching impedance should then permit achieving a low vswr. Retuning the coils may be necessary if a large change is made in the center matching impedance.

A grid dip meter or other instrument such as the Omega-t Systems antenna noise bridge can come in handy to find out the resonant frequency of the antenna before tuning. The antennas are generally made with slightly longer coils than necessary to permit adjustment to various conditions. The 18 in. dipole for 15 meters has a jumper from the center conductor to the first turn to bring the antenna into tuning range. The jumper is a piece of bare copper wire soldered at the ends.

For the amateur who likes to experiment, or the amateur with limited space for antennas, these antennas have many interesting possibilities. For the amateur who has everything, one for portable use, or maybe for use just for the fun of shocking someone by saying, "I'm using a 4 ft dipole antenna on 40 meters," may be the order of the day. . . . K9LGH■

HIGH PERFORMANCE CONVERTER FOR 6



Alan Wilson WA9HES
308 East Wood Street
Hillsboro IL

Been looking around frantically for one of the good old converter circuits? Here's one that uses a Nuvistor for high gain and low noise on 6 meters.

The first addition to my 6 meter station was the converter described below. The unit is designed with the idea of obtaining high performance with a minimum of circuitry. I will attempt to describe the unit in such a way that it can be easily duplicated.

Circuit

A 6CW4 Nuvistor serves as the rf amplifier. Oscillator and mixer functions are provided by a single 6U8A. The 6CW4 must be neutralized, but the low noise figure obtained by the use of this tube makes the extra effort worthwhile. The pentode section of the 6U8A is utilized as the mixer. This arrangement provides adequate output for any reasonably sensitive receiver.

The oscillator uses the triode section of the 6U8A. A third overtone crystal determines the frequency. In my unit a 43.2 MHz crystal gives coverage from 50.2 to 50.5 MHz using the 40 meter band as an i-f. Other crystal frequencies could be used to cover other segments of the band, or if a general

coverage receiver were employed, a 43.0 MHz crystal would cover the entire band with output between 7 and 11 MHz.

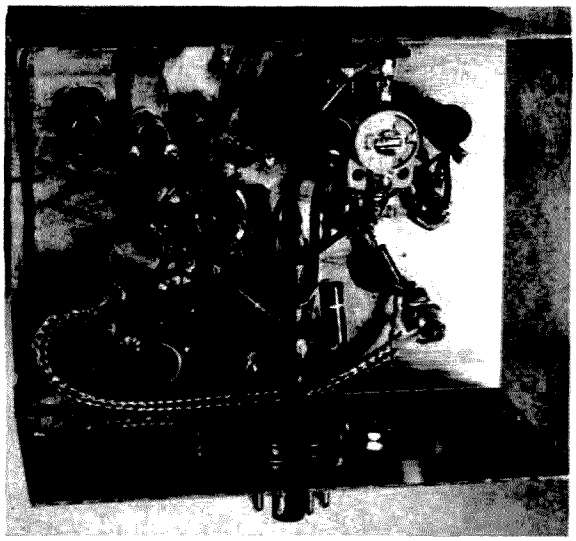
Construction

In order to obtain optimum results the converter should be built in accordance with good VHF practices. All components should be mounted rigidly, keeping the leads as short as possible. Prewound Miller coils are used throughout. Note that the mixer output coil is from the 21A000RBI series. A coil of the same inductance but from the smaller 20A000RBI series would not allow for winding the output link. I used silver mica capacitors for all tuned circuit and coupling purposes. Small tubular ceramics would serve as well. All bypassing is done with 1000 pF ceramic discs.

The only critical part of the converter is the neutralization circuit. The 1.5-7 pF neutralizing capacitor must be secured solidly. The body of the 6.8 kΩ resistor should be positioned as close to the lower end of L3 as possible. This is necessary because the resistor has a dual purpose. It functions not only as a series dropping resistor but also serves to keep the bottom of L3 above ground.

Tuneup Procedure

The first step after applying power is to adjust L7 for maximum rf output as indicated by a grid dip meter in the wavemeter



The rf stage with the associated neutralizing circuitry is at the upper left. Output from the mixer is coupled to J2 via a length of RG-58/U.

position. Next, connect a short length of wire to J1 and set the grid dip meter to generate a 6 meter signal. Now connect the converter to the receiver with a short piece of coax and adjust L5 for maximum signal as indicated on the receiver's S-meter. Next, set the neutralizing capacitor at midrange and tune L2, L3, and L4 for maximum signal strength. Now disconnect the 6.8 kΩ resistor from the high voltage source and adjust the neutralizing trimmer for *minimum* signal as noted on the S-meter. Finally, reconnect the resistor and repeak all five coils. The converter is now set for near optimum performance.

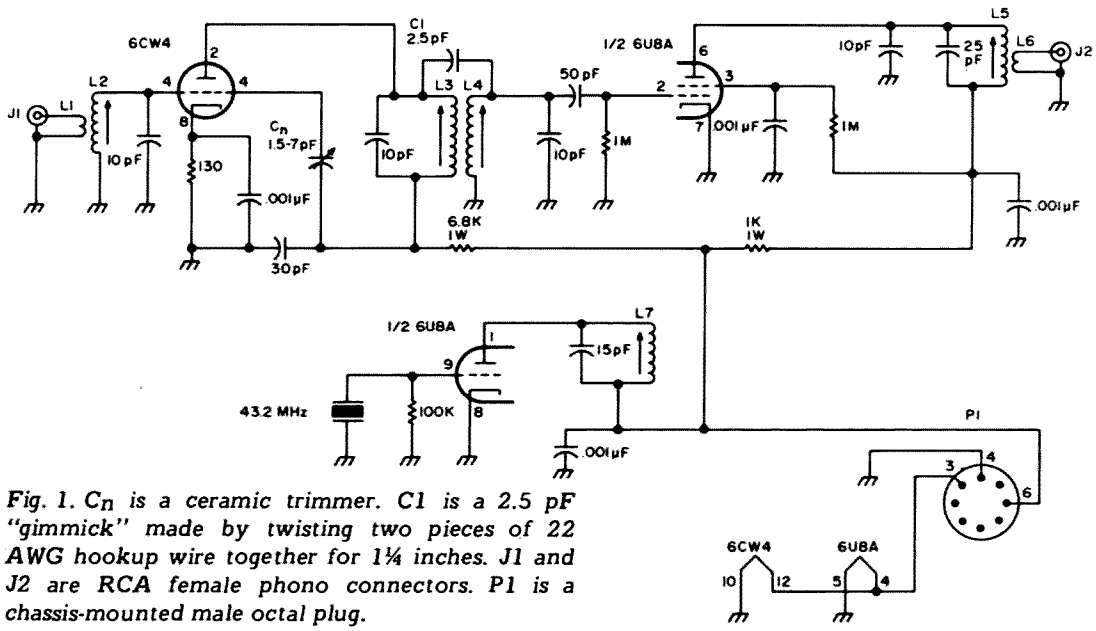
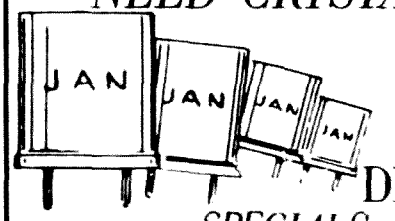


Fig. 1. C_n is a ceramic trimmer. C1 is a 2.5 pF "gimmick" made by twisting two pieces of 22 AWG hookup wire together for 1¼ inches. J1 and J2 are RCA female phono connectors. P1 is a chassis-mounted male octal plug.

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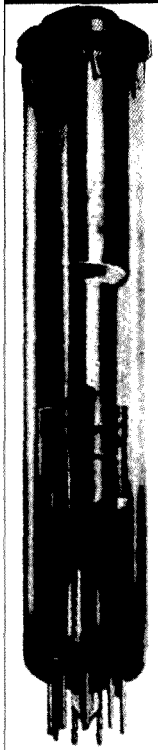
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Power Supply

The power source used should supply +150V and 6.3V with minimum current ratings of 50 mA and 750 mA, respectively. The high voltage should be regulated. In my application a single OD3 regulated supply serves both the 6 meter converter described here and a similar 2 meter converter. The high voltage is continuously on in both units at all times, and the filament voltage is applied to the converter in use.

Coil Data

L1	3½ turns No.22 insulated over L2
L2, L4	Miller 20A687RB1
L3, L7	Miller 20A827RB1
L5	Miller 21A155RB1
L6	5 turns No.22 insulated over L5

L3 and L4 spaced ¾ inch center to center

Results

After using the converter for several months, I am completely satisfied with its performance. At no time have I experienced problems with stability or the "birdies" commonly encountered in VHF converters. When the band is open the converter pulls in the weak ones, yet does not suffer from cross-modulation effects with the locals. If you build the converter as shown, I am sure that you will be thoroughly pleased. Be seeing you on 6.

. . . WA9HES■



How to get into one of today's hottest money-making fields—*servicing 2-way radios!*

More than 5 million two-way transmitters have skyrocketed the demand for service men and field, system, and R & D engineers. Topnotch licensed experts can earn $12,000 a year or more. You can be your own boss, build your own company. And you don't need a college education to break in.

HOW WOULD YOU LIKE to earn $5 to $7 an hour... $200 to $300 a week ... $10,000 to $15,000 a year? One of your best chances today, especially if you don't have a college education, is in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire trucks, taxis, planes, etc. and Citizen's Band uses—and the number is growing at the rate of 80,000 per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Most of them are earning between $5,000 and $10,000 a year *more* than the average radio-TV repair man.

Why You'll Earn Top Pay

The reason is that the U.S. doesn't permit anyone to service two-way radio systems unless he is *licensed* by the FCC (Federal Communications Commission). And there aren't enough licensed experts to go around.

This means that the available licensed expert can "write his own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. Others charge each customer a monthly retainer fee, such as $20 a month for a base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

How to Get Started

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC License. Then get a job in a two-way radio service shop and "learn the ropes" of the business.

2. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move out, and start signing up your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you $5,000. Or you may be invited to move *up* into a high-prestige salaried job with one of the same manufacturers.

The first step—mastering the fundamentals of Electronics in your spare time and getting your FCC License—can be easier than you think.

Cleveland Institute of Electronics has been successfully teaching Electronics by mail for over thirty years. Right at home, in your spare time, you learn Electronics step by step. Our AUTO-PROGRAMMER® lessons and coaching by expert instructors make everything clear and easy, even for men who thought they were "poor learners."

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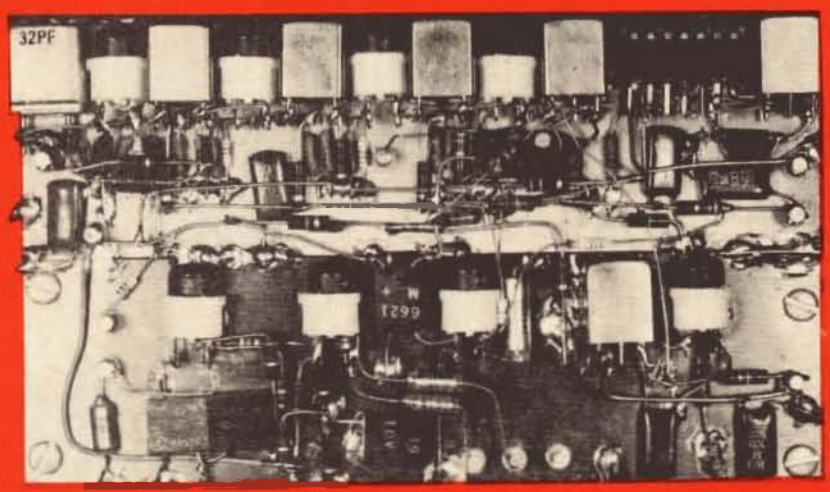


He's flying high. *Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. "I found my electronics lessons thorough and easy to understand. The CIE course was the best investment I ever made."*



Business is booming. *August Gibbemeyer was in radio-TV repair work before studying with CIE. Now, he says, "we are in the marine and two-way radio business. Our trade has grown by leaps and bounds."*

from BREADBOARD *to* Printed Circuit *the easy way*



. . . . . a sneaky system that gives you "professional" boards fast !

How many times has a particular circuit caught your attention and interest only to be passed by because you didn't have the exact components and you felt that you didn't want to put all the work into constructing it if there was a chance that you might not be able to get it to function? Perhaps the thought of changing various parts and having extra holes in the finished product deterred you. Many people, myself included, like to construct an item once and have it work properly with minimum changes. The more complex the circuit or meticulous the work, the less I like to make changes.

Since the average junkbox seldom yields all the specified components for any project, how are we to avoid unnecessary effort in construction projects? After many miles of solder joints a method has evolved which I believe is the most direct route from circuit to finished product, be it chassis or printed circuit board.

Breadboarding

The first step was to evolve a minimum-effort method of breadboarding a circuit, particularly eliminating drilling, mounting, and hardware wherever possible. An arrangement was sought whereby minimum material was used and this material could be used over, time and time again for other circuits. Another requirement was that the method be consistent with good VHF wiring techniques.

What followed was an extremely simple system consisting of two basic components, a piece of copper-clad printed circuit board, and a quantity of inexpensive miniature terminal strips. The board can be purchased at almost any electronic supply house or from any number of mail order firms for about $2 a square foot. The miniature terminal strips are also inexpensive.

At first a selection of multilug strips were purchased as well as the single-lug strips; however, after many projects if was found that the multilug strips were seldom used as most circuits were constructed with the single-lug strips. The miniature terminal strips are a lot easier to work with than their normal sized predecessors, and enable you to get a higher component density for a given area of copper-clad board.

The method is simple to use; merely decide where on the board a connection is to be made between two conductors and simply solder down the foot of the terminal strip in that spot (see Fig. 1).

Conductors to be grounded are soldered directly to the board. In this manner the entire circuit is constructed and changes require only the resoldering of a terminal lug. I usually keep my component leads as long as the circuit considerations will allow; after completion of the breadboard phase, I can unsolder everything. The components are then used in the actual finished product and the terminal lugs can be used again. I am still using the same dozen lugs that I originally purchased five years ago!

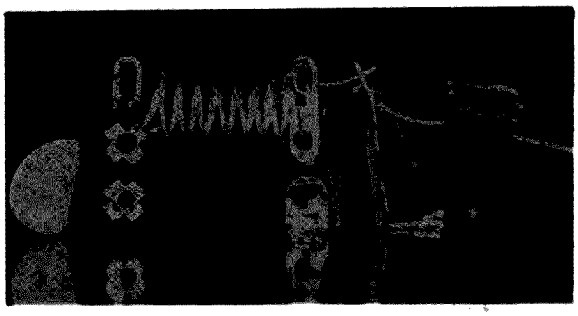


Fig. 1. Terminal strips simplify prototyping because of the ease with which they can be soldered to a copper-clad printed circuit board. (Photo by G. Gfrerer.)

PC Construction

Once an operable circuit is realized, you will no doubt wish to put it in some finished form. The most common packaging technique is the printed circuit mounting arrangement. This appears to be a lot of work to the average person, and most of the "simple" methods described in articles on the subject tend to leave doubt in readers' minds.

After trying many methods I found a way which satisfied these basic requirements:

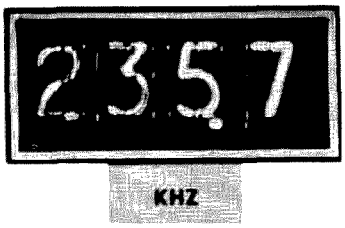
- Only one chemical required
- Minimum artwork
- Minimum time between circuit and printed board
- Capability of small quantity production if desired
- Ability to directly utilize PC layouts already in magazine articles

The key to the entire system is a flexible clear plastic sheet which has adhesive on one side. This is sold as an inexpensive method for plastic laminating of documents. One large envelope contains two 8 x 12 in. pieces for 99¢.*

If you would like to build an item from a magazine article and the author has printed the artwork for his board, you're home free. Cut the artwork out, and stick one or two layers of laminating plastic on each side of it. Take a razor blade and cut out all of the conductor areas and remove them. You now

*Clean-Vu Plastic Film Protector, Sterling Plastics Co., Mountainside, NJ.

Feature This



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Electronic counters belong in the laboratory . . . because they're big, expensive, precision instruments . . . right? So what's one doing in the CX7? Well, it gives you . . . . . .

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SIGNAL/ONE engineers did it by putting state-of-the-art technology to work in a precision counter no larger than a small book. This remarkable unit actually counts each individual cycle of VFO output during a precise (crystal-controlled) 1/100 second time interval . . . and displays the last four digits of the total on an electronic readout. (For example, a VFO frequency of 3521.7 kHz (3,521,700 cycles/second) yields a 1/100 second count of 35,217 . . . and the display shows 521.7 kHz). The readout is as accurate as the 1/100 second timing. Timing is derived digitally from the 100 kHz reference standard. So, by simply zero-beating the 100 kHz oscilator to WWV (or a BC station) you automatically calibrate the VFO to 100 Hz accuracy . . everywhere.

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have a piece of plastic laminated paper with holes in it, which we will call a mask.

Cut a piece of copper-clad board to size and place the mask on the board. Use a couple of small alligator clips to keep the mask from moving position. Take a can of opaque spray lacquer (any color), and using minimum paint, spray the board and mask. The board and mask should be lying on a flat horizontal surface, and you should be spraying straight down.

Be sure to shake the paint thoroughly and hold it about 12 in. away from the board. Some practice may be necessary in spraying to keep the paint from running. The job may be done with a series of light sprayings with about 5 min. drying time between. Once you have finished spraying, lift the mask up vertically from the board to avoid smearing the paint.

After allowing the painted surface to dry 30 min. we can correct any feathered edges in the painted areas. These will sometimes occur to varying degrees because the mask will not usually lay perfectly flat on the board. This can be alleviated to some extent by using more layers of plastic on each side, but it then becomes more difficult to cut the mask. A sharpened ink eraser will easily rub away smears.

After the board is prepared to your satisfaction, immerse it in a plastic or glass tray of ferric chloride or iron perchloride. These solutions are now commonly sold in supply houses under the description of "etchant."

The etching time will vary with the strength of the etchant, its temperature, the thickness of the copper layer, the amount of agitation, etc.

Once the unpainted copper has been completely etched away, remove the board from the solution. But be especially careful to avoid getting any acid on you or your clothing! Carefully wash the board with lukewarm water and soap.

The lacquer may be removed by a variety of means. The easiest way is to brush on lacquer thinner, which removes it very quickly. Or it can be removed with steel wool or a kitchen scouring pad.

The remaining copper should be coated with solder to protect it from corrosion.

This also builds up the conductive cross section. Do this with 60/40 solder and a soldering iron. After depositing the solder, wash off excessive resin from the board with lacquer thinner.

The only remaining steps are to drill holes in the board at the appropriate spots for the component leads, and the actual mounting and soldering of the components themselves. The mask may be stored and used to make future copies of the circuit board, if needed.

What we have done so far is perhaps the easiest method, that of using an already existing conductor layout. Only a few additional steps are needed to design an original layout. Plan the conductor pattern on a sheet of quadrille graph paper (8 x 8 squares to the inch), drawing in the symbols for the components, actual size. Transfer the conductor pattern below the drawing on the same page and use this as your mask, saving the original as a guide to drilling holes and installing actual components in the board.

High-Density Packaging

Sometimes we may wish to get a large number of components in a small volume, or our circuit has many conductor crossing points and does not lend itself well to printed circuitry. Classic "chassis" construction can be ruled out because by using such things as transistor sockets you have most of the components under the chassis, and the socketed components, transistors or whatever, protrude from the top. This dimension from the top of the chassis can be eliminated and a saving in space realized.



Fig. 2. With a copper-clad board as a base plate, very high-density packaging can be achieved by mounting bulky components, such as miniature relays, i-f cans, and crystals, on their sides. This receiver section packs 90 components within the volume of a 3 x 5 in. board! (Photo by G. Gfrerer.)

HAM HOSPITALITY

How about Johannesburg?

Dan Mahony ZS605 offers his home for visiting U.S. hams. His address is 88 Milton Road, Lombardy East; telephone 608-1454. Area: 1 acre. (9½ miles southwest of Johannesburg Centre. Children welcome!

Accommodations: Guest room with private bath. Ham shack makes nice spare bedroom for junior ops.

Reciprocity: 1 day, particularly in California area.

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English speaking DX and U.S. hams welcome. Plenty of advance notice requested. We have two boys (ages 6 and 8) and 330 acres. Overnight accommodations are 10-15 miles away, but we could put up 1 or 2 people in an emergency. Interests are flying, model railroading, music, and art. Wife's tastes: weaving, crafts, music, art. Particularly interested in meeting Rotarian hams.

*Ed. Note. Dave Flinn is owner of Stellar Industries (ham equipment dealer and 73 advertiser).

My home will be open to visiting DX Hams.
William G. (Jerry) Allnoch WA4TST
507 Pinecone Street
Waycross, Georgia
(912-283-0285)

Hospitality offered: meals, snacks, and possibly overnight accommodations, if they don't mind sleeping on a couch in the livingroom.

George Pataki YO2BO/2
34-24 76th Street
Jackson Heights, N. Y. 11372
(212-639-3195)

Visiting DX'ers: Tour CBS, visit radio clubs, meet other hams. I'll serve as your guide around town.

The technique is simple. Using a piece of copper-clad printed circuit board as a base plate, mount all sockets and major components such as i-f cans on their sides. An example of this is the i-f section of a receiver, such as that shown in the photo of Fig. 2. The transistor sockets are epoxied to the board and the i-f cans are soldered to it. The minor components are then soldered onto the terminals of the sockets and i-f cans as required. An inherent disadvantage to this type of system is that it is not as rugged and cannot take as much physical abuse as a printed circuit.

It is hoped that this discussion will give some ideas to experienced builders, and encourage the novice to delve deeper into this rewarding hobby.

. . . K1AOB/3■



C. W. Wandrey WA9EHE
915 North President St.
Wheaton Il 60187

THE CAMPER: Mobile and Portable

More than just a mobile, the camper can become a base station on wheels.

One of the things I was anticipating with joy when I took an early retirement was the additional time that I could spend operating my rig. Unfortunately, I also enjoy traveling, so, during two years of retirement, my wife and I spent only seven months of this time at home. Some of our traveling was done overseas, but that which we did in the States was primarily done in our VW camper. With the advent of the many deluxe overnight trailer and camper parks throughout the country, traveling in a VW camper allows one to do a maximum amount of traveling at a minimum of cost, a must when living on a retirement income! So now our problem was how to enjoy traveling and ham radio at the same time. One of the things that spurred us on to find a solution was the fact that our son, in Thousand Oaks, California (W6GST) is also a ham and enjoys following us on our trips via ham radio. Here's how we worked it out.

The ambient noise level in a VW camper is relatively high, particularly when driving at high speeds. Also, the available space below the instrument panel is rather limited. We decided that we would limit our mobile operating to Citizens' Band and operate the amateur bands on a portable basis. The first problem to be solved was the antenna mount. The standard ones available didn't seem to have the desirable mechanical strength to allow us to mount a variety of antennas (including a full-length telescoping vertical for 40 meters. With the use of stainless steel (ordinary plated steel or brass could be used) and some plastic rod, I concocted the mount shown in Fig. 1. We normally drive using the Citizens' Band for on-the-road communications (Fig. 2). It is surprising how many of the long-haul truck drivers have CB units in their truck cabs. They are usually most anxious to carry on a conversation, particularly when they are driving the lonely open stretches out west. In addition to providing a delightful pastime while driving, CB communication can be rewarding. Some gas station chains on our major interstate highways constantly monitor Channel 9, which makes them available in case one runs out of gas, has a flat tire or other mechanical trouble, or—most important—in case of emergency. The Heathkit CB transceiver was mounted as shown in the photo without any interference with the driving controls. It was simple to trim the antenna to its proper length with the help of a vswr meter and the ground plane area provided by the large area of the VW camper roof gives about a 5 mile range for reliable mobile operation with enough volume to overcome the ambient engine noise.

For operating portable in the ham bands, I selected appropriate Heliwhip antennas, wound and tuned at the factory for my selected favorite frequencies; however, they are fairly broadbanded and allow operating over a spectrum either side of the specified frequency. I'm sure a Hustler or some other multiband antenna will be just as satisfactory, and it is just a matter of personal preference. At home, I use the Heathkit SB-301, SB-401, SB-200 combination, and we chose the SB-100 and the Kompact Kilowatt HA-14 for use in the camper. The

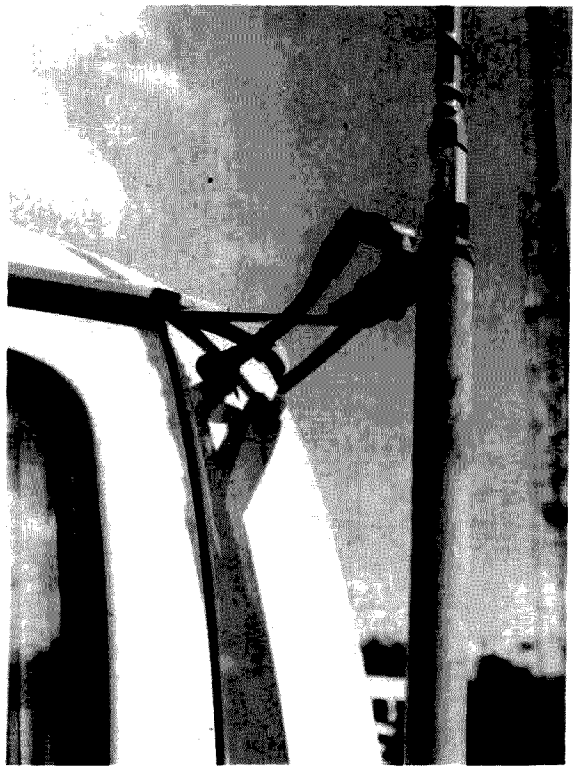
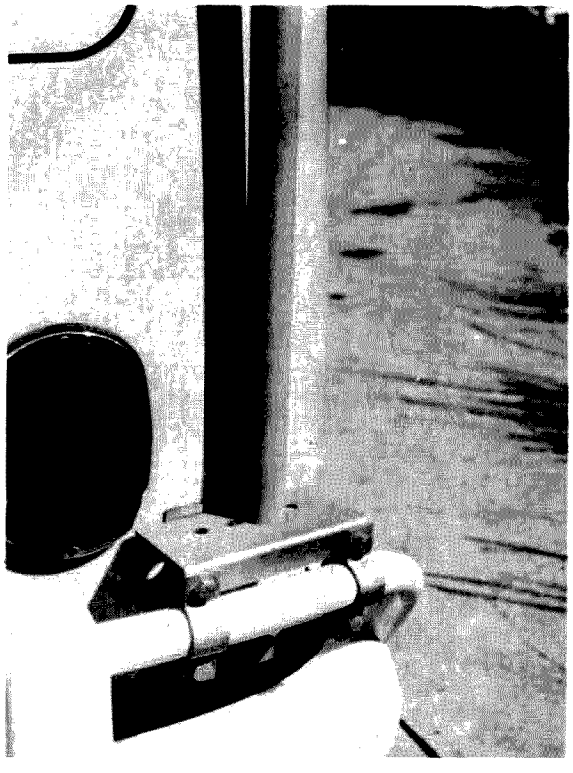


Fig. 1. Homebrew mount places antenna high above the street, yet is stable and electrically sound.



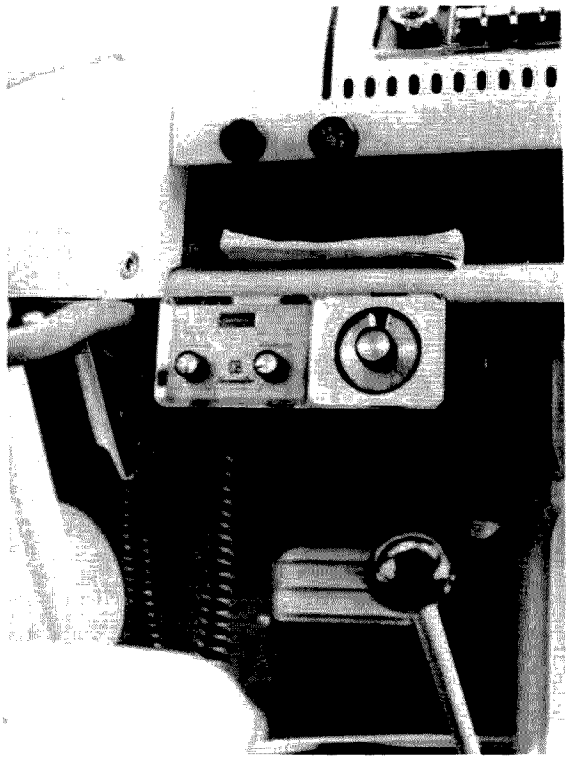


Fig. 2. On the open road, the Heathkit CB transceiver keeps us in touch with the world. It is comforting to know that one CB channel is monitored on a national scale by many of the gas station chains.

combination icebox and portable sink which is standard equipment in the camper was removed and replaced with a foam ice chest purchased for 88¢ and a plastic water jug costing less than one dollar. These are stowed in any convenient place in either the trailer and camper, and to us are actually more convenient and flexible than the original equipment. The space vacated by the icebox provided an excellent place to mount the radio equipment. To make the installation neat and stable we constructed a rack (Fig. 3) from some old plywood that many years ago had done duty as a Ping Pong table. As shown in the photo, adequate ventilation must be provided by drilling as many holes as possible without impairing the strength of the rack.

Wooden stops are positioned behind the two rear rubber feet of the Kompact Kilowatt, the transceiver, and the power supplies. This prevents them from sliding to the front (rear of the rack); large washers, with off-center holes drilled in them, screwed to the front of the rack, prevent movement in the opposite direction. The height of the shelves is such that if the equipment should bounce, it will still be held captive by the stops and screwed-on washers. The bottom of the rack holds a Honda 300W gasoline engine power supply. This unit is very quiet in operation and surprisingly light in weight, considering its output capability. This unit also delivers 12V dc for battery charging in case of emergency. I drilled a small hole to run the coax from the antenna inside the camper. The hole was then sealed with a plastic rubber sealer compound. This made a perfectly waterproof joint. Though most of the private trailer parks include free electricity, some of the state and national parks do not. When juice is available, of course we use it, and this allows us to use the full kilowatt. When the gasoline power supply is used, we operate barefoot. It is quite a sensation to be sitting on the side of the highway talking to someone several thousand miles away and get 20-over-9 reports.

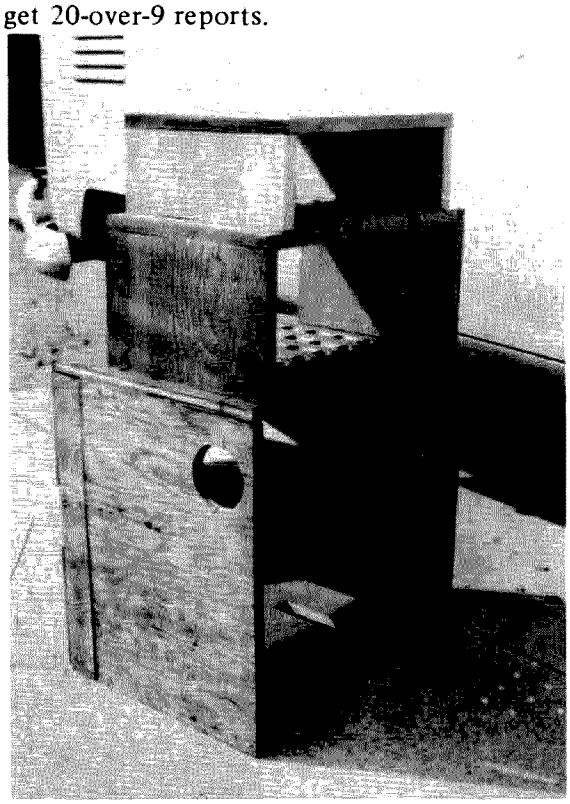


Fig. 3. Equipment rack replaces icebox of original camper. Lots of air holes help to dissipate the heat generated by the units.

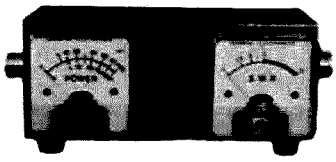
I'm sure my wife would rather leave the cooking equipment home than the radio equipment—especially when we have a schedule with our son.

. . . WA9EHE ■

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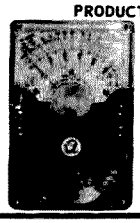
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You Think You Have Troubles?

Take the case of Charlie Damico W3VXO. Charlie is one of our sightless hams. However, he has not allowed his handicap to get in his way. He is employed in electronics, repairs all his own gear, with few exceptions, can rig up an antenna without help, and seems to get along just fine.

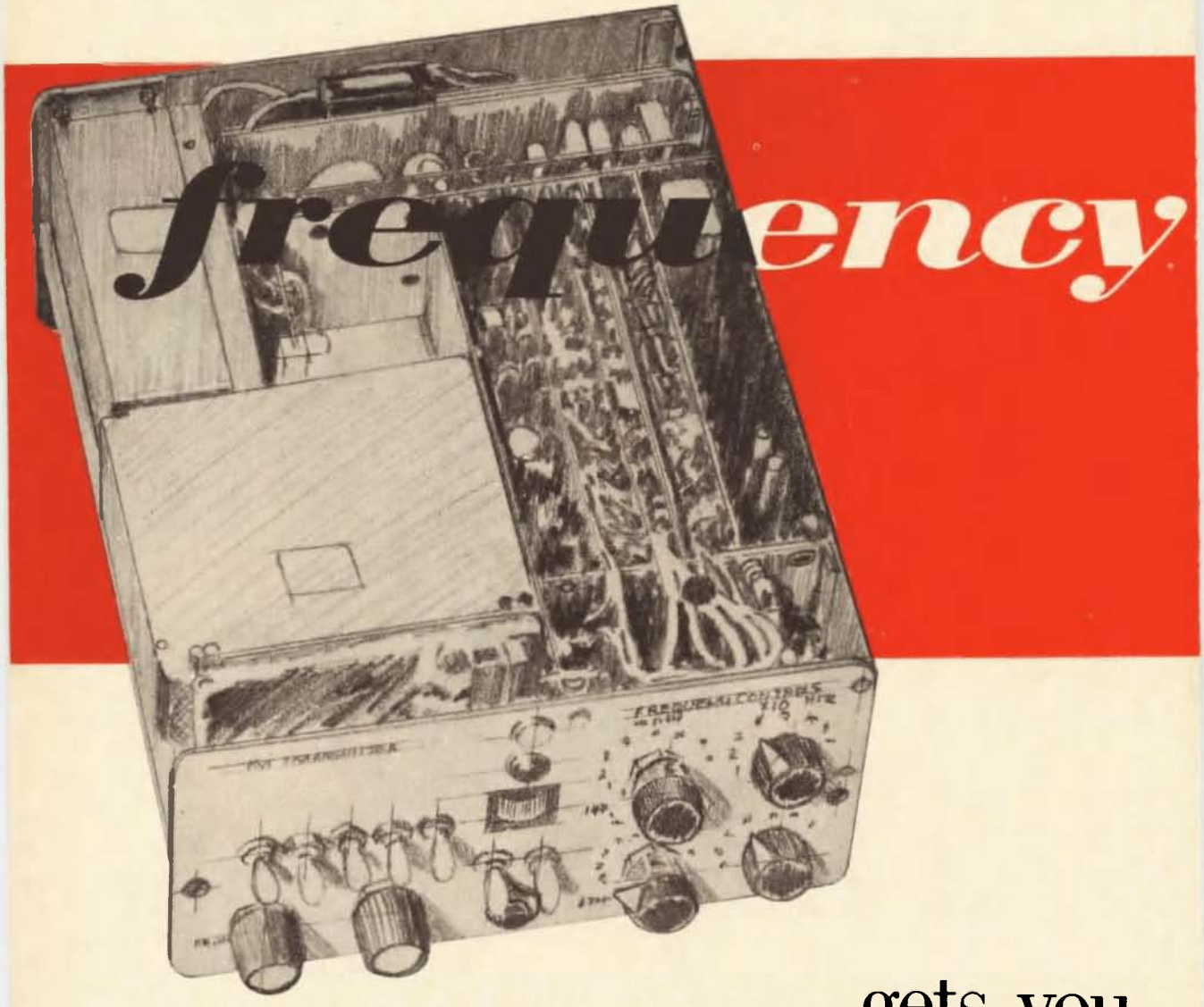
A few months ago, he began getting TVI complaints from one of his neighbors. This fellow (who lives in the City of Brotherly Love, incidentally) really got hot under the collar and began circulating a petition around the neighborhood.

The FCC stepped into the picture and investigated the complaints. After finding that Charlie was putting out a clean signal and was not creating interference on a good TV set, a committee questioned the 20 signers of the petition to find that 14 of them thought they were signing a petition for someone running for Mayor of Philadelphia. Of the remaining six, four had had no interference, but were friends of the original complainant; the remaining one was willing to drop the subject upon installation of a highpass filter. So, Charlie was left with one irate neighbor.

One would think this would be the end of the story. Unfortunately, this was not the case. One night, Charlie came on the air and said, "You know, something seems to be wrong here. I'm not getting the right readings on the output of this rig, and I can't figure out what might be wrong." We all noted that his signal was not up to its usual strength, but he was still readable. After checking his swr, he came to the conclusion that something was wrong in the antenna. He left the air. The following night he told us the story. *Someone had cut his coax feedline to his 75 meter dipole.*

Charlie had gone up to the roof and strung a Marconi antenna to get back on the air.

. . . Kayla Hale W1EMV ■



gets you
400 channels,
frequency-standard accuracy
with just one crystal!!

Gil Boelke shows how it's done...

synthesis

the modern way to control frequency

by Gilbert Boelke W2EUP

A complete and comprehensive article covering theory and techniques of indirect frequency synthesis, plus schematics and a description of a practical 400-channel synthesizer used in a two-meter FM transceiver with only one frequency-determining crystal.

I
THE PROCESS

Frequency synthesis is the term used to describe the process of synthesizing (or "putting together") many frequencies from a small number of starting frequencies. In theory, any number of channels may be so generated from only one master oscillator, using the electronic techniques of adding, subtracting, multiplying, and dividing frequencies. In practice, the larger the number of channels the more worthwhile it is to go the synthesizer route.

A *direct* synthesizer uses such conventional techniques directly, filtering the undesired output products at each step in the process. This technique has the disadvantage that many high quality filters are required to reduce the undesired (spurious) output frequencies to the desired extent.

An *indirect* synthesizer uses a voltage-controlled oscillator to generate the output signal, electronically "steers" it to the correct frequency and "locks" it there. Its main advantage is that the output needs no filtering; it comes from an on-frequency oscillator. All spurious products are kept within the confines of the synthesizer loop (with any luck) and do not appear in the output.

Figures 1 and 2 illustrate two ways a synthesizer can be used. In Fig. 1, the synthesizer covers the full range of transmitter and receiver frequencies for a General Electric TPL unit. An extra X8 multiplier must be added to the receiver so that both re-

* 505 Main Street West Seneca, New York 14224

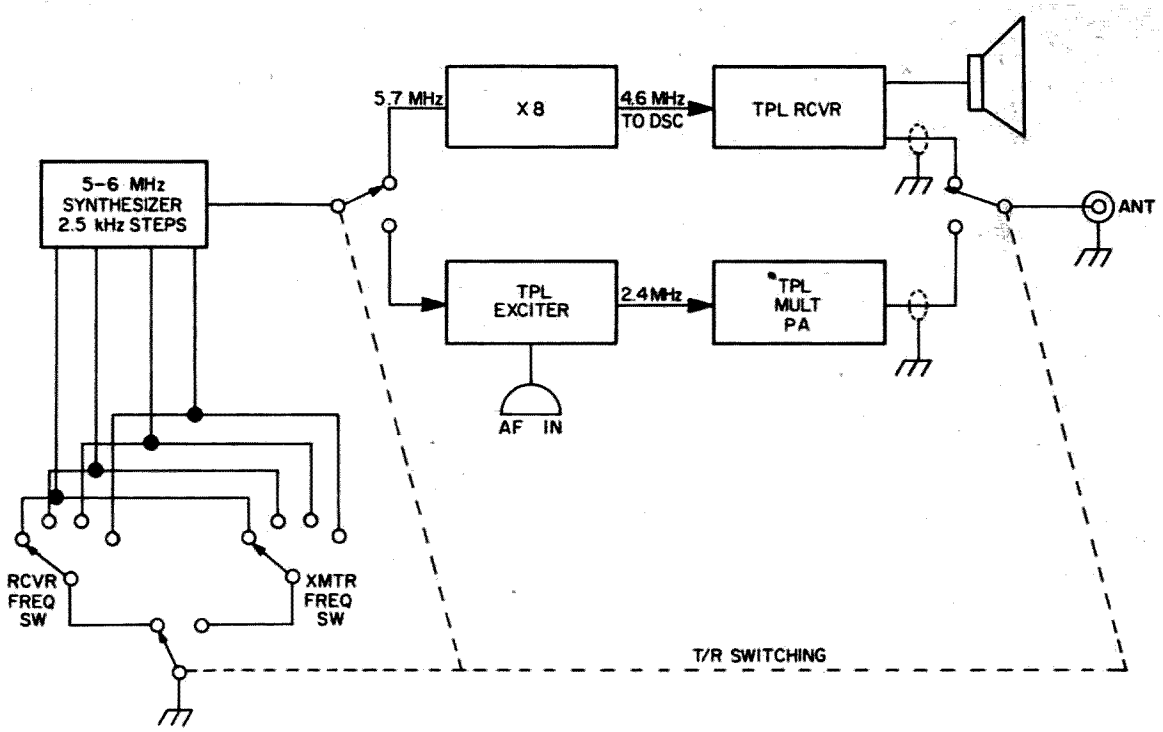


FIG. 1 How to use synthesizer for 60 kHz incremental switching in existing units

ceiver and transmitter multiply the synthesizer output by 24, to make channel spacing the same for both receiver and transmitter.

Although a synthesizer could be built as a crystal oscillator substitute for existing types of equipment, it can be more effectively exploited in a "start from scratch" design, as shown in Fig. 2. True FM can be produced by direct modulation of the synthesizer, eliminating the need for a phase modulator or frequency multiplication to build up the deviation level. Or, as a receiver local oscillator, a synthesizer can just as well be designed to deliver the oscillator injection frequency directly, eliminating the need for frequency multipliers.

Figures 3 and 4 show block diagrams representing the synthesizers used in Figs. 1 and 2. The synthesizer block diagram of Fig. 3 generates 2.5 kHz steps in the 6 MHz range. Used to drive existing transceivers, this arrangement produces 60 kHz steps in the two-meter band. If the range is extended to 5.7 MHz and the output multiplied by 24, the same synthesizer can be used for the receiver.

Addition of a mixer and a multiplier as in Fig. 4 makes it possible to generate 60 kHz steps directly in the two-meter band. A separate crystal oscillator is used to heterodyne the output signal down to a frequency suitable for division. By switching crystals — in this case to 141 MHz — the synthesizer output can be moved down 9 MHz to provide oscillator injection for a receiver having a 9 MHz i-f. These mixer injection frequencies could also be obtained by suitable means from the basic reference oscillator, rather than adding two more crystals.

How it Works

Consider the simplified synthesizer of Fig. 5. This example is for a 5 — 6 MHz output range in 10 kHz steps. A tunable VCO (voltage-controlled oscillator) is used to generate the output signal; in doing so, of course, it must tune electronically from 5 to 6 MHz by varying the dc input voltage. The stability of such an oscillator doesn't even begin to match that of a crystal oscillator, but it *does* have the flexibility of operating on any channel in the desired range. So the remainder of the circuitry is devoted to detecting the VCO frequency,

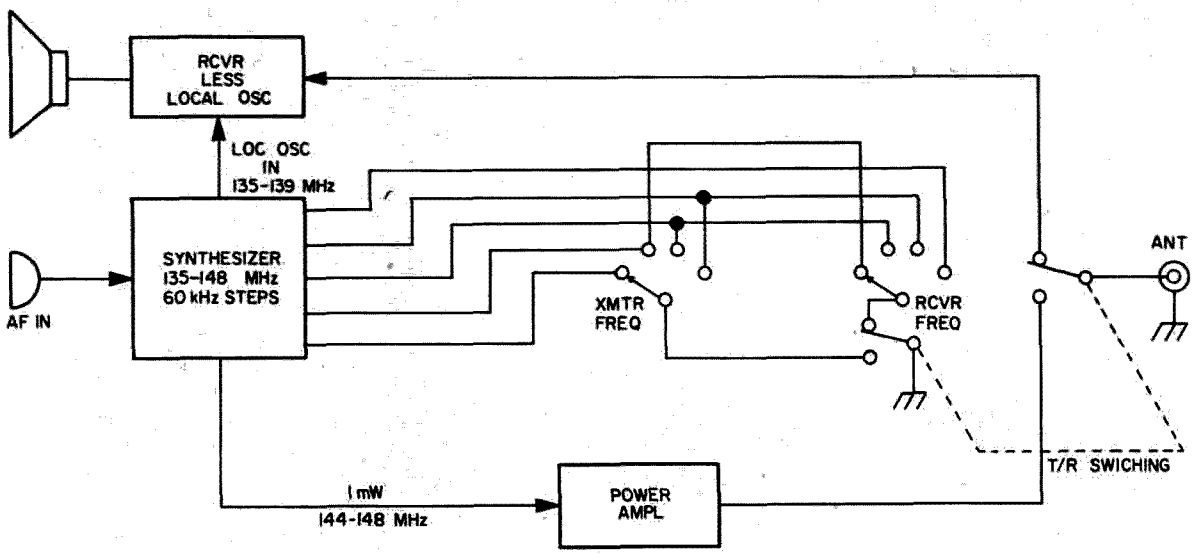


FIG. 2 Synthesis of local oscillator and transmitting frequencies eliminates frequency multipliers and greatly simplifies receiver design

relating it to the *desired* frequency, and adjusting the oscillator *electronically* to it.

Spacing of the output steps is determined by the reference frequency. In this case, a 10 kHz reference means that the circuit can lock to any harmonic of 10 kHz such as 5.000, 5.010, 5.020, 5.030 . . . etc. to 6.000 MHz. Direct multiplication could be used to get the same result, but it would be nearly impossible to eliminate undesired harmonics of the 1 kHz signal, even with the best of filters. So, instead of multiplying 10 kHz to, say, 5 MHz, start with the VCO at (or near) 5 MHz and divide it by 500 instead. This function is accomplished in the programed divider ($\div n$, or "divide-by-*n*"). Consisting of a chain of flip-flops, this circuit can be programed to divide by any ratio between 500 and 600. When it divides the 5 MHz output of the VCO by 500, the result is 10 kHz.

The phase detector circuit compares the $\div n$ output to the reference signal, delivering a dc output proportional to the phase difference between them. This dc level controls the VCO. When the VCO output drifts from exactly 5 MHz, the output of the $\div n$ will drift in exact proportion to it since it always is 1/500th of the output signal. The phase detector sees this as a phase change and shifts its dc output to the phase detector immediately to steer it back to 5.000 MHz exactly. Since it compares phase instead of frequency, the frequency at the $\div n$ output is never permitted to shift so much as one hertz either way, and the output of the VCO is held precisely to 5.00 MHz. *Frequency accuracy depends only upon the stability of the reference frequency oscillator.*

To change frequency to 5.760 MHz it is only necessary to change the *divide* ratio of the $\div n$ circuit by switching the programing inputs of the $\div n$. Since this is a larger divide ratio than 500, the $\div n$ output will at first be below 10 kHz. The phase detector senses this shift as a phase change in the very first cycle following the shift and immediately starts action to correct it. When the correction is complete, the $\div n$ output is again on 10 kHz, but the VCO is on 576 X 10 kHz, or 5.760 MHz.

The synthesizer of Fig. 3 is only a little more complicated than the basic unit of Fig. 5 . Since 2.5 kHz steps are desired, the reference frequency must be 2.5 kHz. Stable crystals of this frequency are not notably practical, so a 1 MHz master oscillator is used, divided down to 2.5 kHz by a series of flip-flops. A harmonic of the 1 MHz signal is conveniently adjusted to zero-beat with WWV, thus precisely aligning all channels to frequency. A higher divide ratio is necessary in the $\div n$ circuit due to the lower reference frequency, as shown.

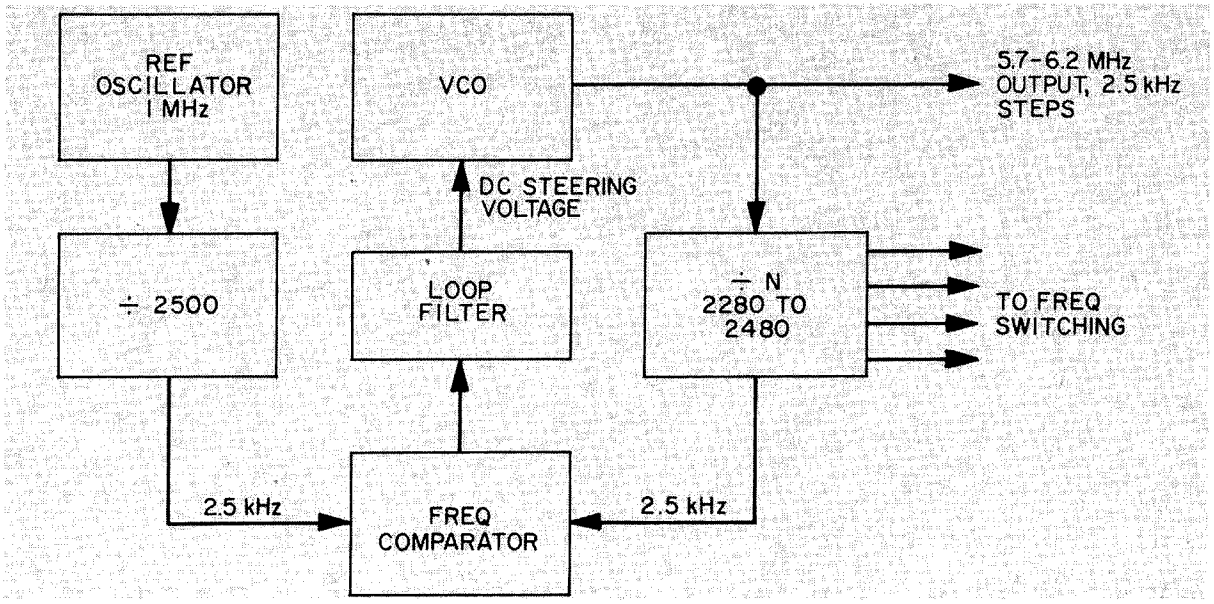


FIG. 3 Block diagram of synthesizer for use in existing transceivers (see also Fig. 1)

The loop filter, necessary in all cases, must remove all traces of the reference frequency at the output of the phase detector (in this case 2.5 kHz). A simple *RC* low-pass filter configuration is usually employed.

The next step in synthesizer development, shown in Fig 4, has a VCO operating in the 135 — 148 MHz range, heterodyned to the 2 — 6 MHz range. This mixing process is necessary because present-day low-cost flip-flops can only divide to about 8 — 10

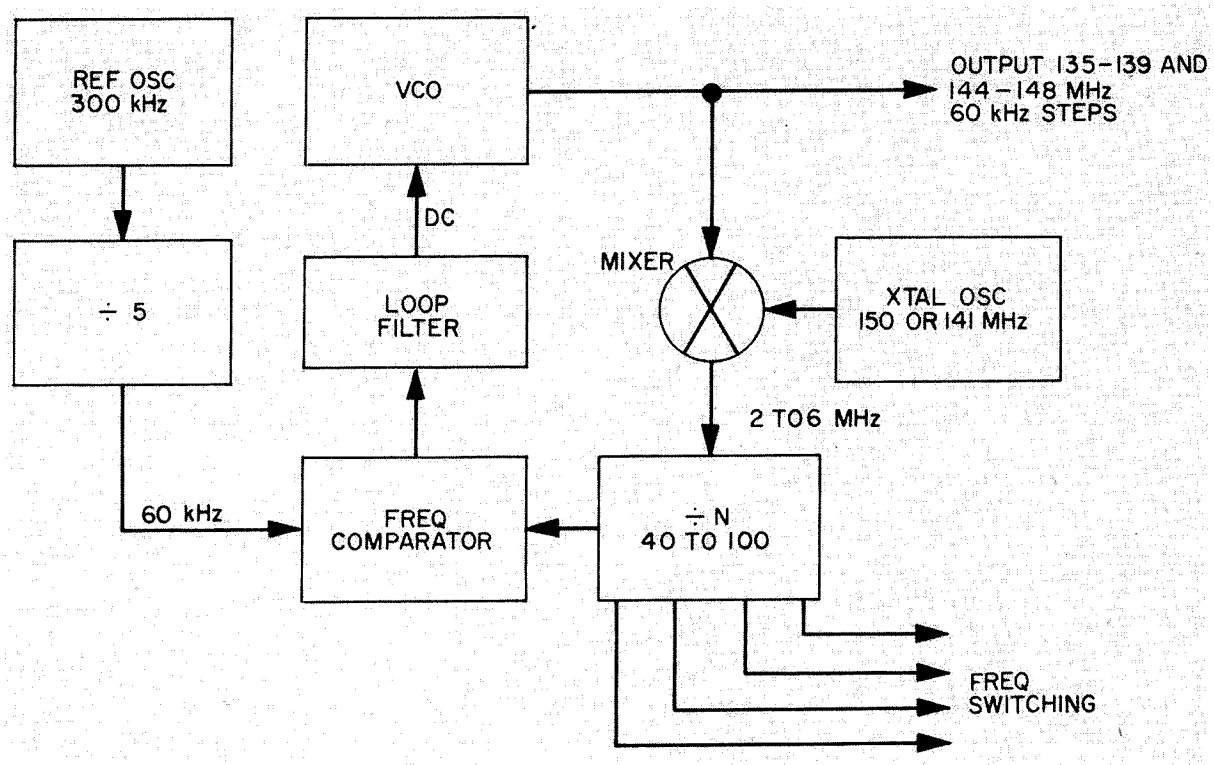


FIG. 4 Block diagram of synthesizer incorporating a mixer and multiplier for generating 60 kHz steps directly in two-meter band

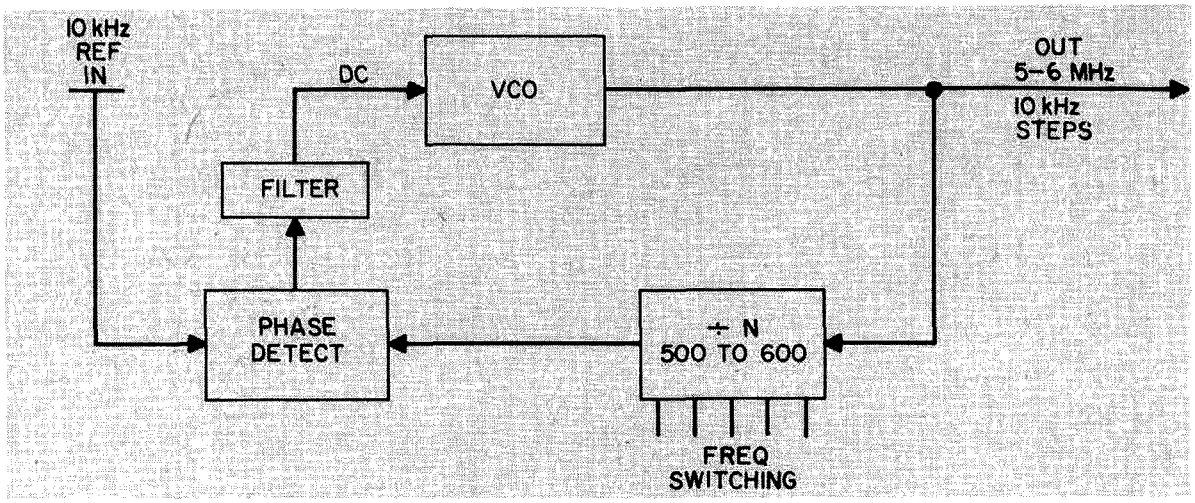


FIG. 5 Simplified synthesizer diagram

MHz in a programed divider circuit. A 60 kHz reference can be used to generate 60 kHz steps because the signal is not multiplied in the receiver and transmitter as in Fig. 3 , thus simplifying both dividers greatly. Frequency stability in Fig. 4 depends mainly upon the accuracy of the 150 and 141 MHz oscillators. Frequency adjustment is necessary in all three oscillators with this scheme. Judicious selection of the frequency spacing, reference oscillator frequency, receiver i-f, and the mixer injection frequencies can result in a design that uses a single crystal.

The Phase-Locked Loop

Indirect frequency synthesizers are basically feedback systems, where phase error is detected and fed back as a correction signal. Such a closed loop is called a phase-locked loop. As a consequence, certain rules must be followed to keep the system stable, as in any feedback system.

The phase-locked loop must have a loop filter at the output of the phase detector to prevent rf from leaking into the VCO control signal (which should be as clean a dc signal as possible). If any rf or ripple appears at this point, it will frequency-modulate the VCO. If the ripple is deliberately applied *as audio*, a desired FM signal can be produced. Undesired high frequency components such as the reference frequency will produce spurious sidebands. Thus, it is the function of the loop filter to remove these undesired products. A second function, however, is to determine the phase — gain characteristics of the loop, which determine its response time, stability, and "capture range."

Capture range is the term applied to the maximum frequency difference the loop will tolerate between the VCO output and the desired output frequency and still *lock up*. Capture range is directly proportional to loop bandwidth. The higher this bandwidth, the higher the adjacent spurious levels — the lower it is, the closer the VCO must be before it will lock up to the desired frequency. A low loop bandwidth also takes longer to lock up. So a compromise is necessary. Despite all of these design criteria, the loop filter is usually a very simple circuit when used in conjunction with a good phase detector.

Phase Detectors

Since the reference frequency of an indirect synthesizer is typically equal to the frequency spacing between channels, the phase detector also operates at this relatively low frequency. The best phase detector circuits are those which deliver the highest ratio of dc to inherent ac ripple. A flip-flop can be used as a digital phase detector, but its output is quite high in ripple content, and it requires a more sophisticated loop filter than other circuits. The

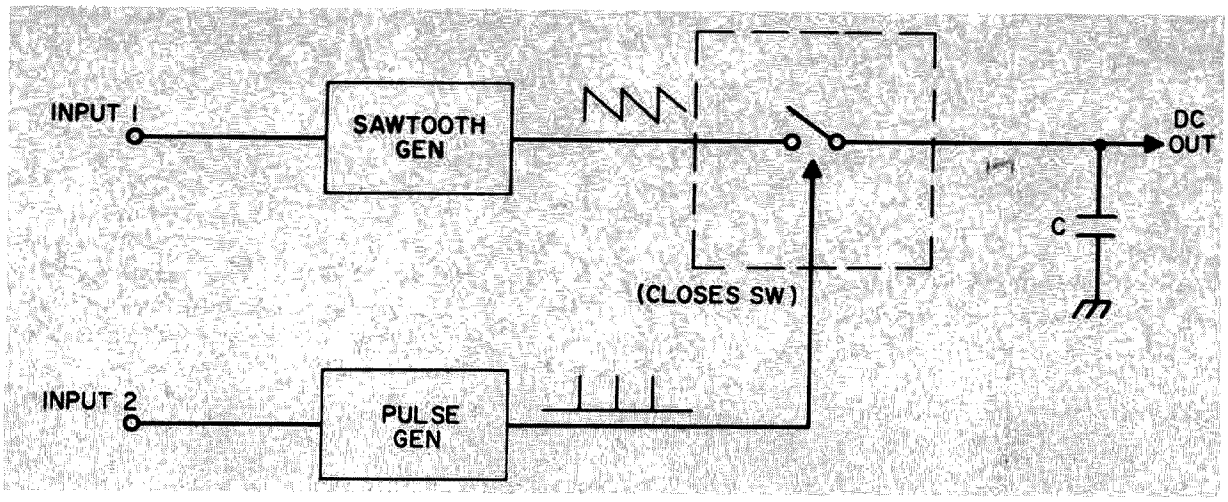


FIG. 6 Sample-and-hold phase detection

best phase detectors in current use work on a *sample and hold* principle. One of the two input signals is converted to a sawtooth, the other to a narrow pulse. The former is called the *ramp*, the latter a *sampling pulse*. As shown in Fig. 6, the sampling pulse operates a series switch for brief intervals so that the value of the ramp voltage at that instant is transferred to a "holding" capacitor. If at the next sampling time there was no change in relative phase between the two signals, the output will not change from the first sample. If there *is* a difference, the output capacitor voltage shifts abruptly up or down to the new value. It can be seen that as long as the two signals are in *phase lock* the output ripple is (ideally) zero. With practical implementation it isn't zero, but it can be made extremely low with careful design.

False Locks

When the phase-locked loop is initially turned on or the frequency is changed, the VCO may be out of the capture range of the loop. Under this condition the synthesizer output is that of the free-running VCO: unstable and at an unknown frequency. The VCO must therefore be tuned to the near vicinity of the desired frequency before the loop will lock up. With most phase detectors a number of *false lock* conditions can occur. A false lock is present when the $\div n$ and the reference frequencies are not equal, but the phase detector "thinks" they are and locks the VCO to the wrong place. A circuit which assures proper acquisitionof the desired frequency is called a "search." It acts as an AFC-type control of the VCO by detecting frequency differences between the $\div n$ output and the reference frequency, rather than phase differences. The search is normally turned off when the phase detector locks the loop. There are a number of ways in which a search can be implemented. Digital methods are compatible with the pulse-type signals available, and they offer simplicity of construction and freedom from adjustment. Best of all, they are nearly foolproof.

$\div n$ Circuits

Except for the advent of low-cost integrated circuits, this part of an indirect synthesizer would probably be impractical to build. It consists of a chain of flip-flops whose function is to divide the VCO signal down to the reference frequency. The number of flip-flops depends upon the maximum divide ratio. Since each flip-flop can divide by a maximum of 2, two can divide by 4, three by 8, etc.; and n flip-flops can divide by 2^n. If the maximum divide ratio is 100, as in Fig. 4, it takes 7 flip-flops, which can divide up to $2^7 = 128$. Six would not be enough because they can divide by only $2^6 = 64$. In Fig. 3, a divide ratio of 2240

is needed; $2^{11} = 2048$, too low; $2^{12} = 4096$. Therefore, 12 flip-flops are needed.

The next problem is to find some way to change the ratio of the $\div n$ by switching so that channels may be selected. Two common methods are used. To understand them, some of the properties of binary dividers must be known. First, the divider can be considered a counter since at each input pulse, or step, the flip-flops take on a unique combination of states. A useful analogy can be drawn to an automobile odometer (mileage indicator), which works in a similar way but counts in decades (powers of ten) instead of binary (powers of two). Including the *tenths* decade, a typical car odometer can count up to 999,999 tenths of miles, and the millionth step brings it back to all zeros. If a switch was provided to close only when all zeros are present, the switch would close once for every 1,000,000 input steps, thus dividing by one million.

One method of changing this ratio would be to reset the odometer to zero whenever it reached the desired count. For example, if a divide-by-567,000 count is desired, it could be accomplished by providing a resetting device which detects the 566,999 state, then resets all decades to zero on receipt of the 567,000th input. By programming the desired state when this occurs, the divide ratio can be any desired number.

Another way is to preset a number into the divider each time it recycles to zero. Achieving a $\div 567{,}000$ with this method requires that a 433,000 be inserted when the counter reaches a natural state of all zeros. The counter then counts from 433,000 to 1,000,000, where it is again preset. This count is 1,000,000 minus 433,000, or 567,000.

Presetting is the preferred method because it is usually easier to implement. Design of high-speed $\div n$ circuits is full of subtleties which make it deceptively easy to design on paper, but another matter to make workable.

Frequency Display

Up to about 12 channels, switching and display of the channel in use is a simple matter. For 30 or more channels it can become a problem, because even if a 30-position switch could be obtained, it would be considerably less convenient to

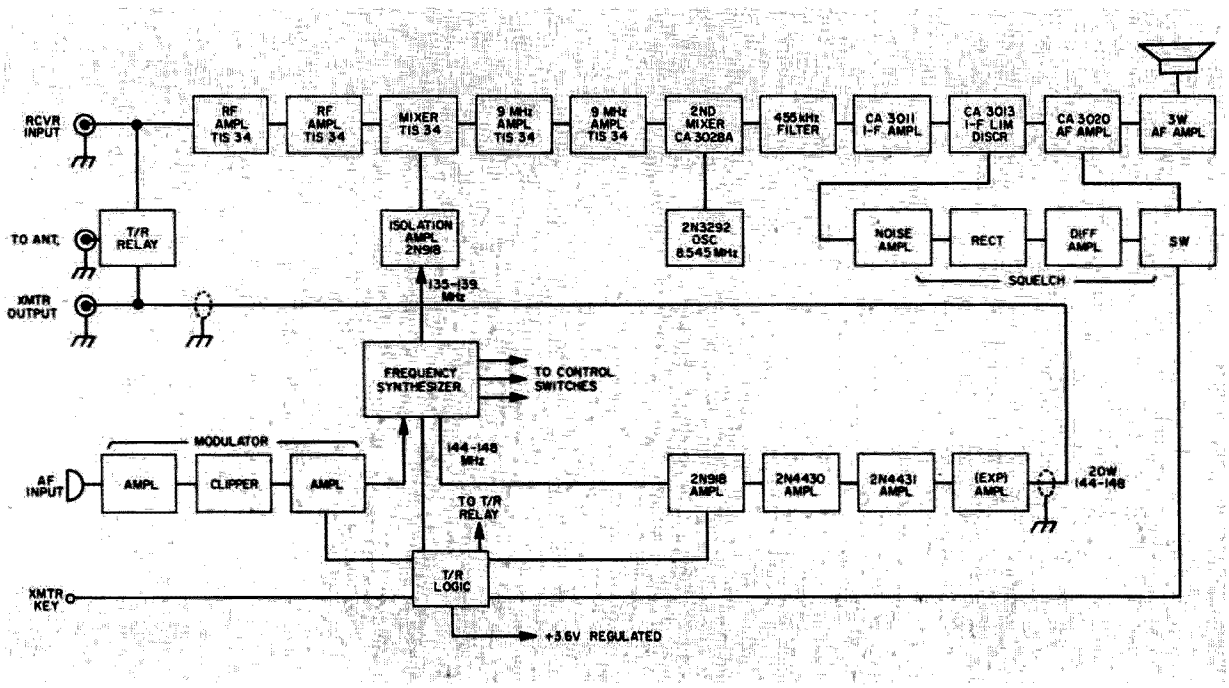


FIG. 7 Block diagram of an FM two-meter transceiver showing how frequency synthesis is incorporated

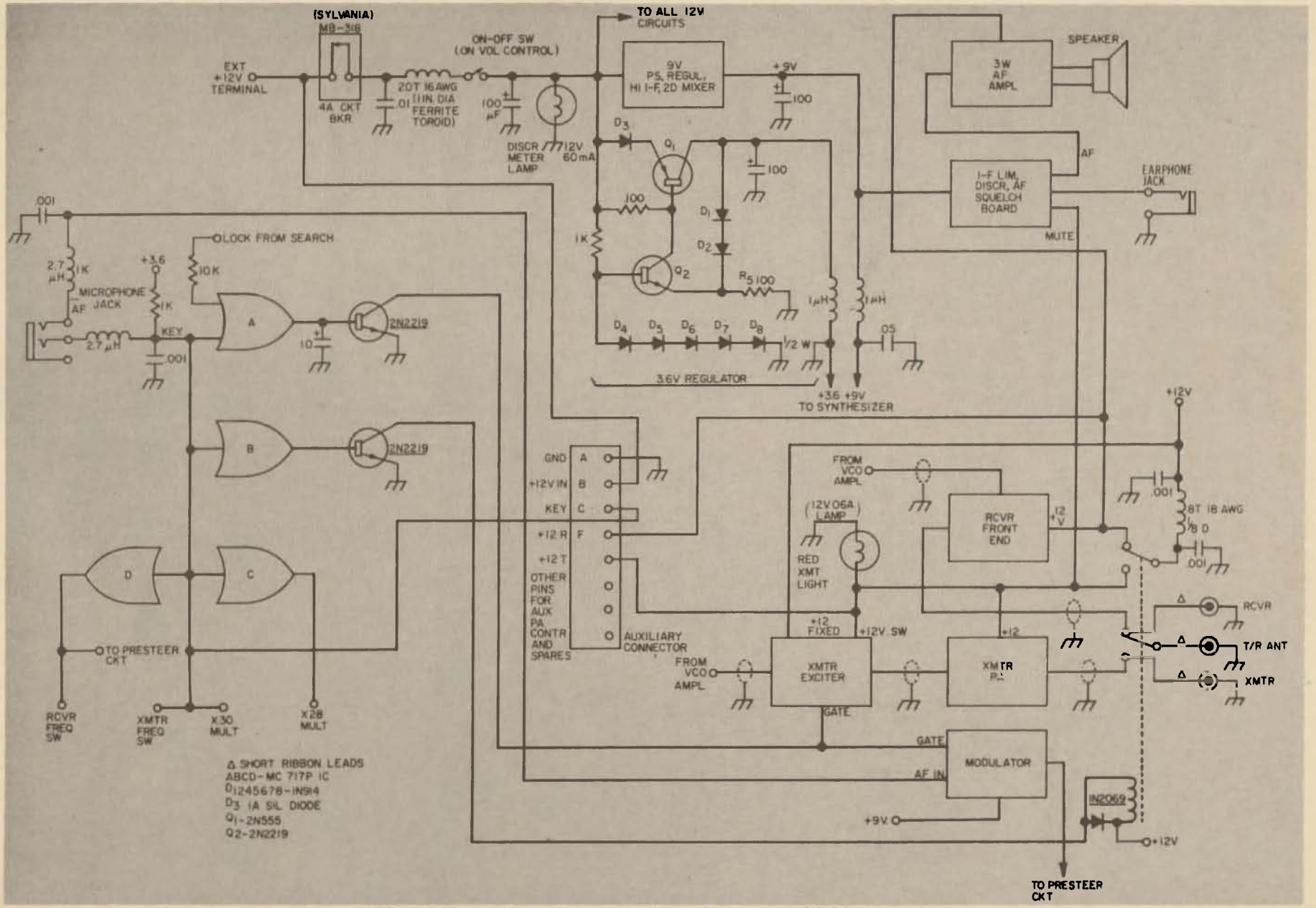


FIG. 8 Transmit and receive wiring for a typical FM transceiver

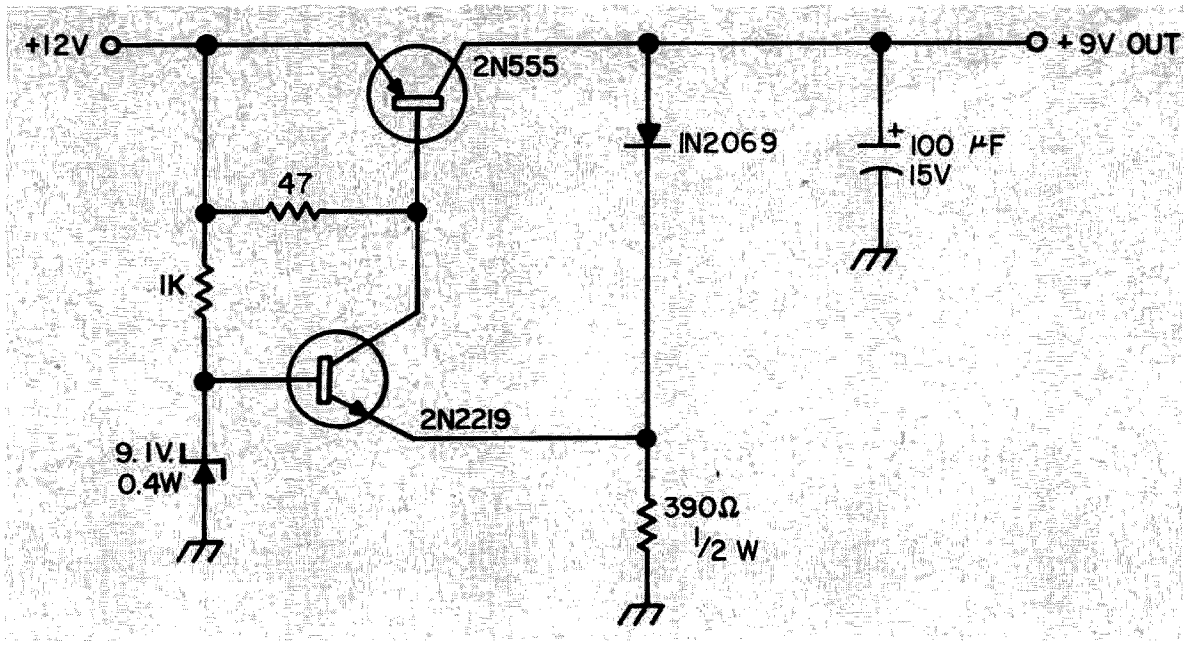


FIG. 9 +9V regulator

find the channel you want than with only 12 channels.

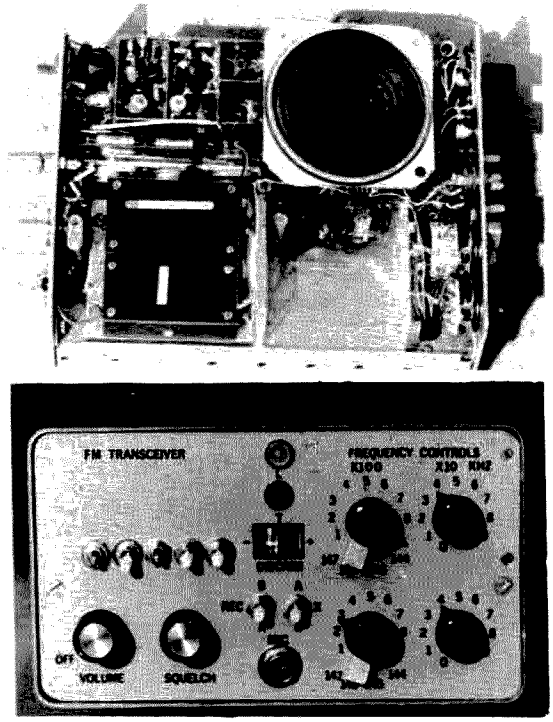
For this reason, switches are usually arranged in a power sequence, such as a *MHz, hundreds of kHz, and tens of kHz* arrangement, extended to as many places as desired. If the $\div n$ were left in its natural state, the switches would have to be set in a binary fashion, which could be awkward. However, the decade type of display is easily accomplished by designing the $\div n$ circuit to work in decades instead of straight binary. It takes 4 flip-flops to produce a $\div 10$ section; cascading three such decades results in a capability of up to 1000 channels. If the channel kilohertz spacing is 1, 10, 100, etc., the frequency display is in familiar decimal numbers. Other schemes can be worked out for different channel spacings, but the decimal method is the most convenient, since most of us think in terms of decimal numbers.

It should be kept in mind that the VCO output is the output of the synthesizer, and even though the loop keeps it exactly on frequency, it can't correct for audiofrequency variations (below the loop filter response). Even if it could, it would be necessary to slow it down for modulation purposes; otherwise the loop would attenuate the audio. Therefore, the VCO of a synthesizer is as sensitive to microphonics as a VFO is, and good VFO construction techniques should be used. VCO tuning range should just overlap each end of the desired output range, and its temperature drift should be kept low to maintain band coverage.

The following text describes the synthesizer used in a 10-kHz-step, 400-channel, 144 — 148 MHz transceiver utilizing a single 5 MHz crystal.

II
A PRACTICAL 10-kHz-STEP SYNTHESIZER FOR TWO METERS

Figure 7 shows the full transceiver block diagram. Output from the synthesizer is 1 mW in the frequency range of 144 — 148 MHz (transmitter), and 1 mW, 135 — 139 MHz, to the receiver first mixer. Modulation is applied directly to the synthesizer for the transmit function. The block labeled *T/R logic* is the circuit board that changes the synthesizer output range when the transmitter is keyed; it also serves to switch the receiver and transmitter and drive the antenna relay.



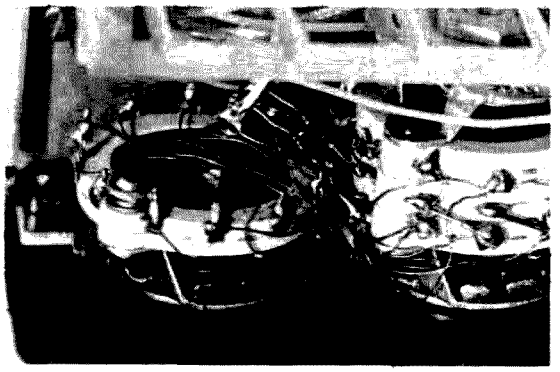
W2EUP'S homebrew two-meter FM transmitter/receiver looks unbelievably professional. The synthesizer controls are the four at the right of the panel. The top pair sets the receiver frequency, the bottom pair sets the transmitter. The basic frequencies of operation are selected by the integral four-position switches (under the X100 knobs). The frequencies of operation on the pictured unit are 146.34 MHz for the transmitter (national repeater input frequency), and 146.94 MHz for the receiver (national repeater output frequency).

Figure 8 shows the transceiver transmit — receive circuits and the system wiring. Two power supply regulators are used; one generates +9V at 250 mA and the other +3.6V at 1A. Nine volts is the B+ level used in the receiver circuits, the transmitter modulator, and the synthesizer. The schematic for the +9V regulator is shown in Fig. 9.

The +3.6V supply is used to provide power for the digital integrated circuits, which are rated for a temperature range of +15 — +55°C (guaranteed performance). Instead of a zener diode, a series string of silicon diodes is used as a voltage reference for this regulator. This technique produces a temperature-programed supply that delivers over 4V when cold and less than 3.5V when hot. The logic works reliably over a very wide range of temperatures when operated in this manner.

Figure 10 shows the synthesizer block diagram. The single 5 MHz crystal oscillator drives, through an amplifier, a ÷500 fixed divider to obtain the 10 kHz reference frequency, and a dual-frequency multiplier section. When in the receive mode, a multiplication factor of X28 is used, producing a 140 MHz signal. When transmitting, a X30 multiplier supplies a 150 MHz signal to the mixer. The multipliers are selected by the transmit — receive (T/R) logic. When receiving, the VCO output range is 135 — 139 MHz (9 MHz below the corresponding transmit frequency). When mixed with the 140 MHz signal, the mixer output ranges from 5 to 1 MHz (140 − 135 = 5; 140 − 139 = 1) and the ÷*n* divide ratio is preset to divide by any number between 500 and 100, to deliver the 10 kHz output. Since 10 kHz is the reference frequency, the channel spacing is 10 kHz. In the transmit mode the mixer produces from 6 to 2 MHz (150 − 144 = 6; 150 − 148 = 2), and the ÷*n* is preset to any ratio between 600 and 200.

The VCO and VCO amplifier are shown schematically in Fig. 11. The B+ to the VCO should be kept small to maintain maximum tuning range. As it turned out in the unit pictured, tuning range was no problem and had to be reduced by trimming the high end of the range with C6. The VCO is housed in a section of the oven assembly, which also contains the 5 MHz oscillator and an electronic temperature regulator. The VCO itself could have been mounted in a nonheated environment without stability problems because frequency drift with temperature turned out



Detail of frequency selection switches show how "MHz" section connections are skewed 1 MHz offset on receive mode. At right an extra detent (switch clicking and locking mechanism) is reversed and mounted behind. A 1/8-inch shaft is attached and brought to panel through drilled-out shaft of front detent. Rear deck is X100 (hundreds of kilohertz, front two are MHz selection decks. Solderable magnet wire was used for connections to keep the wiring manageable.

to be very low. However, in the author's transceiver, the oven insulation also acts as sound and vibration shielding (polyurethane foam), minimizing VCO microphonics.

Radiofrequency shielding is absolutely essential in the VCO. In the prototype unit, the VCO amplifier was mounted in a separate shielded box, but it was later combined with the VCO itself.

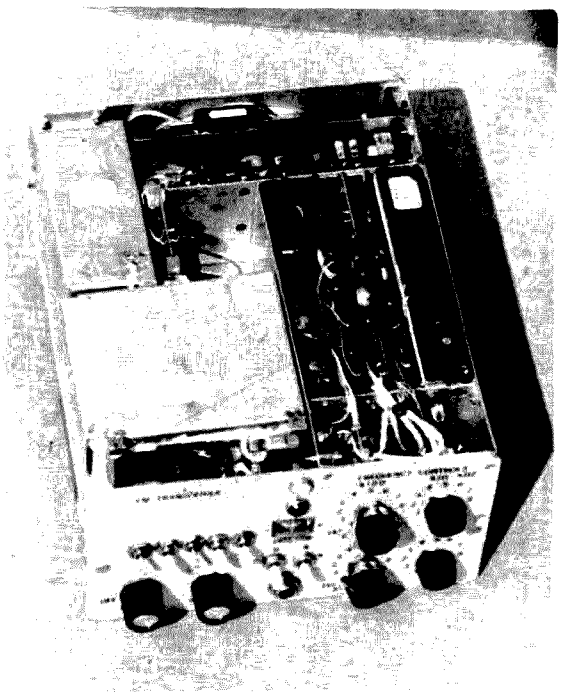
The *steer* input of the VCO comes from the frequency comparator (consisting of the phase detector and search) for electronic lock. An extra varactor (D4) is used to accomplish this by means of a voltage supplied from a presteer circuit (described later) and switched by the T/R circuits.

Three outputs are provided by the VCO amplifier: In addition to the receiver and transmitter outputs, there is a 0.1 mW signal fed to the synthesizer mixer for loop feedback. The resistor network provides some degree of isolation between the outputs. Again, shielding of the VCO amplifier is a must.

Figure 12 shows the frequency multiplier section, the synthesizer mixer and the amplifier used to square up the waveform to feed the $\div n$ circuit. The multipliers are conventional and their outputs are connected in series to feed the mixer. Only one multiplier operates at a time, selected by the T/R circuits. Grounding the X28 or X30 lines selects the desired one.

Mixer output is amplified by several resistance-coupled stages. Transistor Q8 squares the waveform and Q9 acts as an inverter to provide the two out-of-phase signals needed to drive the $\div n$ circuit.

The $\div n$ schematic is shown in Fig. 13. Note that the divider is sectioned into decades I and II and a $\div 8$ section. The terminals shown along the bottom are the



Top view of unit shows circuit board construction and "plug-in" accessibility concept of two-meter FM transmitter/receiver. The two rearmost cards are for receiver. Card next to i-f filter is i-f amplifier. The synthesizer section is shown at right. Left to right, the cards are: phase detect and divide-by-500; search; diode matrices; divide-by-n; mixer-multiplier. The heavy white leads from switches to matrix board are insulating sleeves; each sleeve contains 8 — 12 leads of 32 AWG magnet wire. Slots and holes in shields are similarly guarded with insulation to prevent the possibility of shorts by chafing.

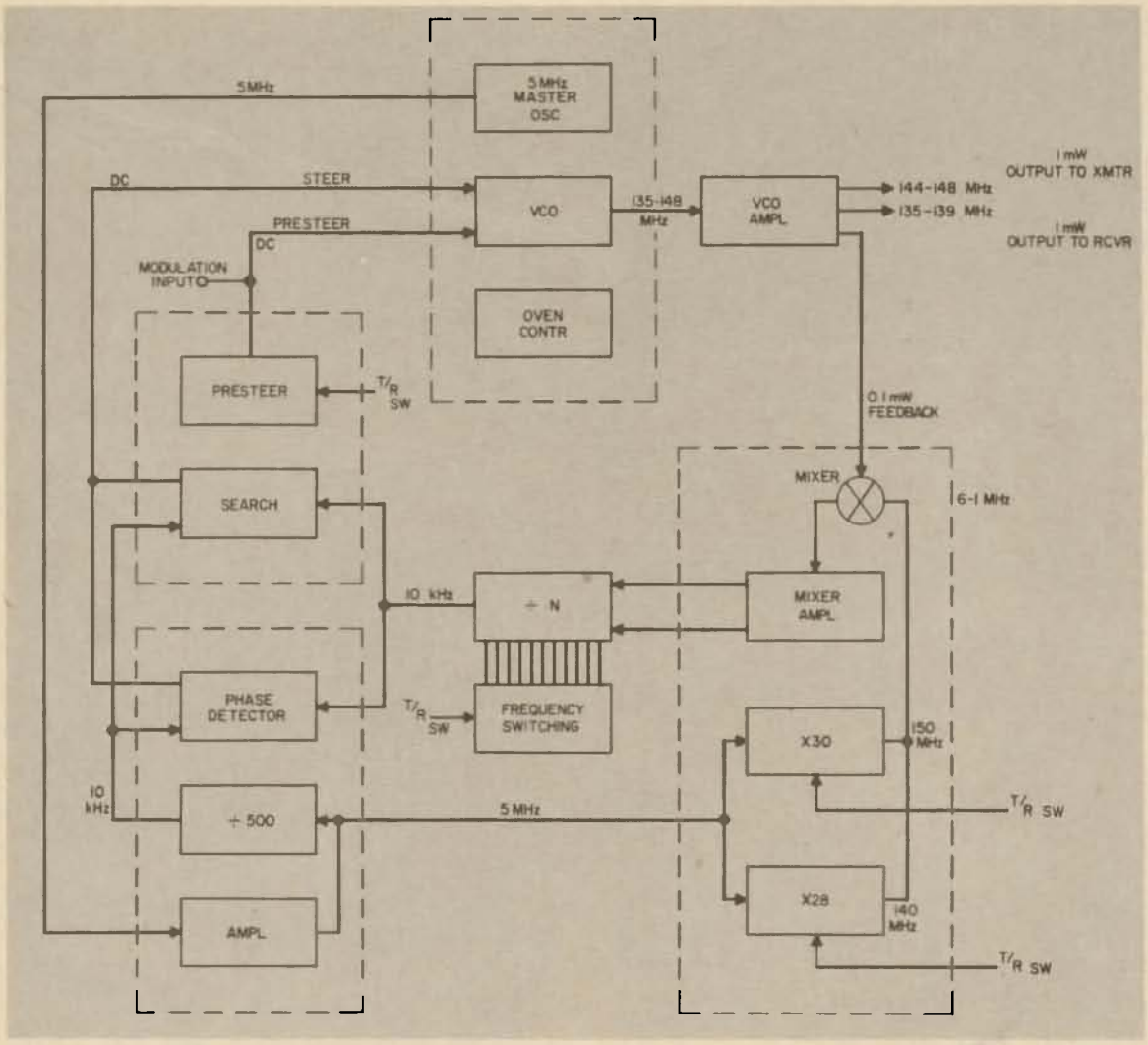


FIG. 10 Detail block diagram of frequency synthesizer

preset inputs. For maximum divide ratio (÷800) all of these terminals are biased to a positive 1 — 4 volts and thus no presets are inserted. Other divide ratios are chosen by selectively grounding (or opening) these terminals. For example, if A1 is grounded, it will divide by 799; if B1 is grounded, it divides by 798; C1 grounded yields ÷796, etc.

A table of presets is given in Table I, showing how the presets affect the divide ratio and the resulting frequencies of operation in this synthesizer. A zero indicates no preset; a "1" indicates a preset on terminals A1 through C3. Under the ÷*n* ratio heading is shown what happens to the normal ÷800 ratio as different combinations of presets are inserted. For example, a preset at A1 only (second line) shows a − 1; this means that the ratio is reduced by a 1 *from 800 to 799. If A_1 and A_2 were both preset*, the ÷*n* ratio is reduced by a 1 and a 10, or 11; therefore, n = 789. Preset lines A1 to D1 thus switch *tens of kilohertz*. lines A2 to D2 go to the *hundreds of kilohertz* switch, and lines A3, B3, and C3 go to the *megahertz* switch.

A 10 MHz shift is accomplished in this design by changing the injection frequency into the synthesizer mixer. Since the receiver oscillator injection requirement is in the 135 — 139 MHz range (to produce a 9 MHz i-f), a 10 MHz shift is necessary to get the output into this range. As previously described, this function is accomplished by the T/R logic selecting the appropriate fre-

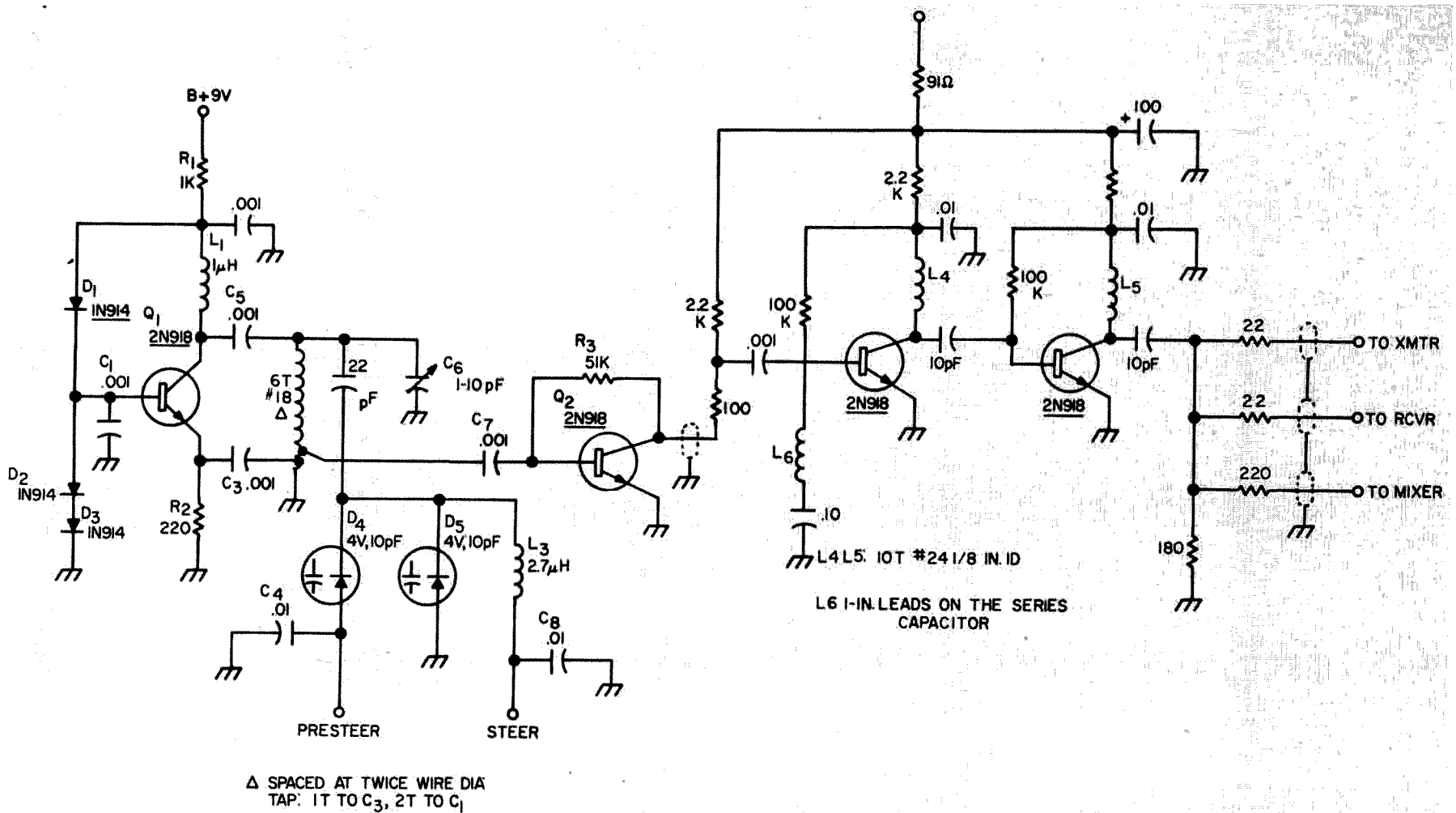


FIG. 11 Voltage-controlled oscillator and associated amplifier

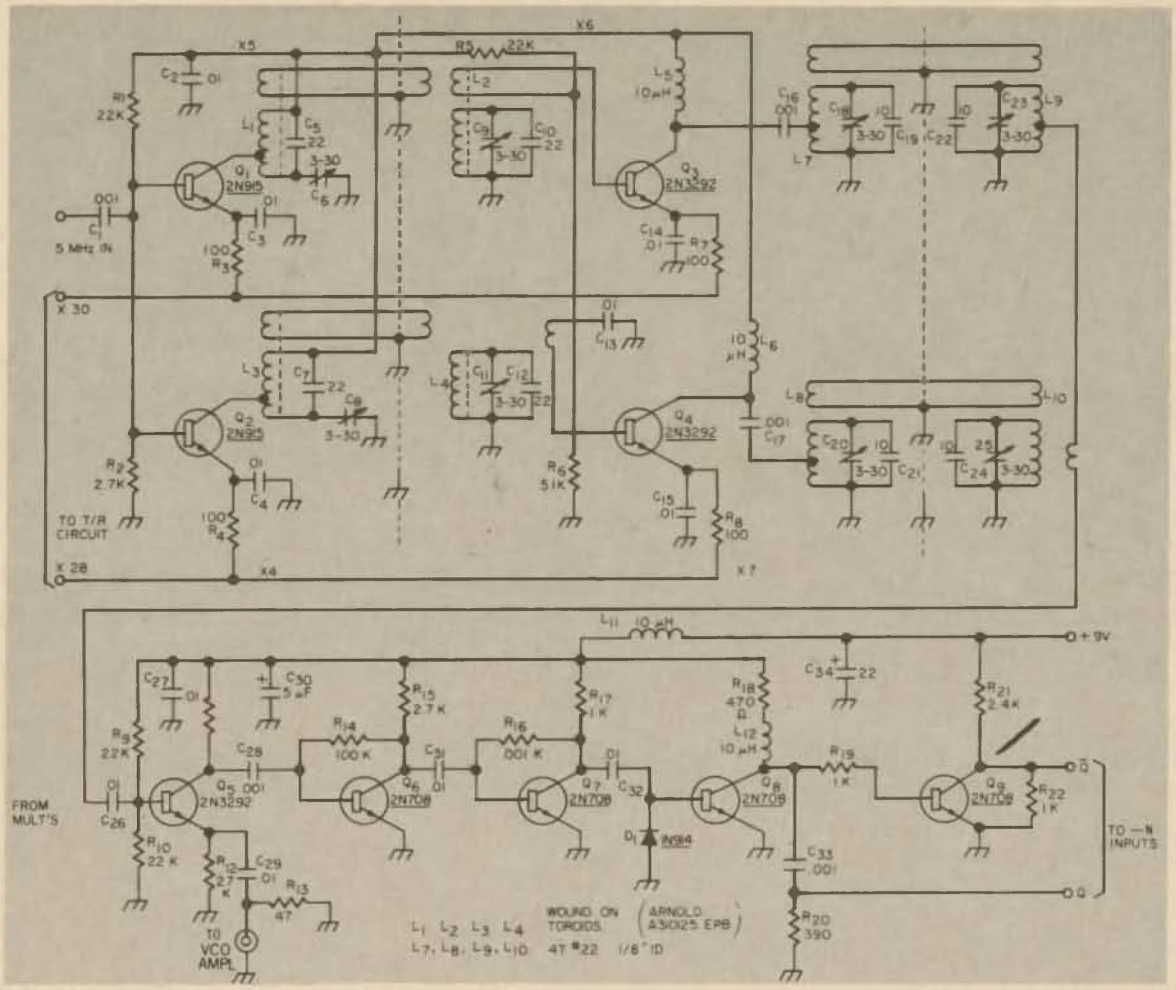


FIG. 12 Multiplier, mixer, squaring amplifier schematic diagram

quency multiplier. However, the MHz preset must also be shifted by 1 MHz to receive the same frequency as the transmitter is on, since only a 9 MHz offset is desired. Thus, as seen in the table, the *receive* presets are offset one place in the MHz column.

The $\div n$ circuit shown is capable of operation to 10 MHz for all presets and represents the results of a hard brainstorming session. It should be reproducible and will work as it is shown, as long as the wiring is correct. Unless you understand its theory of operation *completely* it is recommended that you simply copy it *carefully!* Have someone else check *every connection* since troubleshooting is difficult. Space doesn't allow a complete explanation of its operation.

Frequency switching circuitry is shown in Fig. 14. Two complete sets of switches allow independent selection of receive and transmit frequencies. The diode matrices shown permit the use of standard 10-position rotary switches. Input voltage for the preset lines is provided through the 10K resistors. When one of the lines is grounded, a combination of presets is grounded through the diodes.

The arm of S1 is grounded in the transmit mode, and the arm of S2 is grounded in the receive mode. If S1 is in the *A* position, the transmit frequency is controlled by switch set *A*; if it is in the *B* position it transmits on the frequency on set *B*. The same is true for S2 on receive.

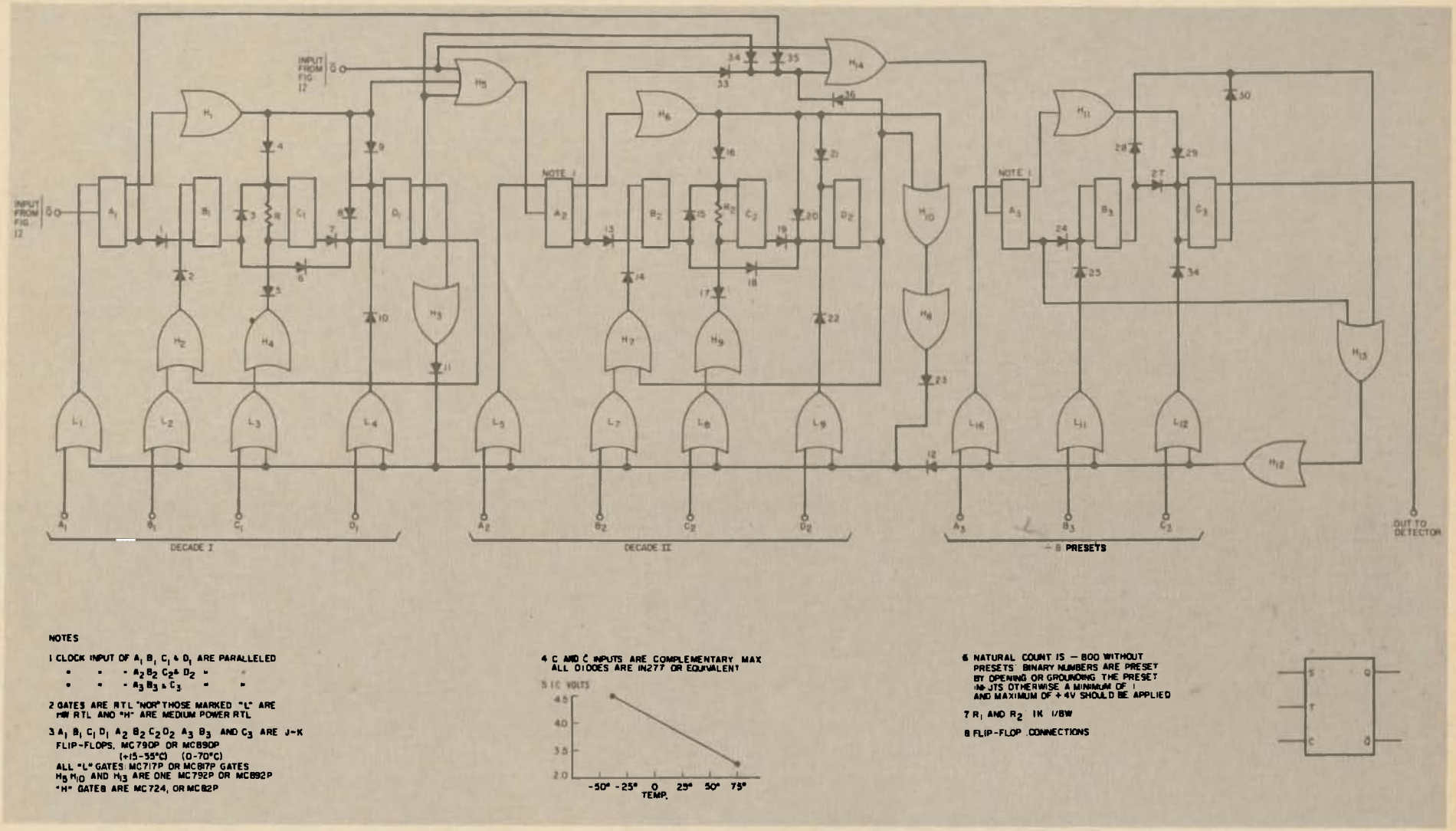
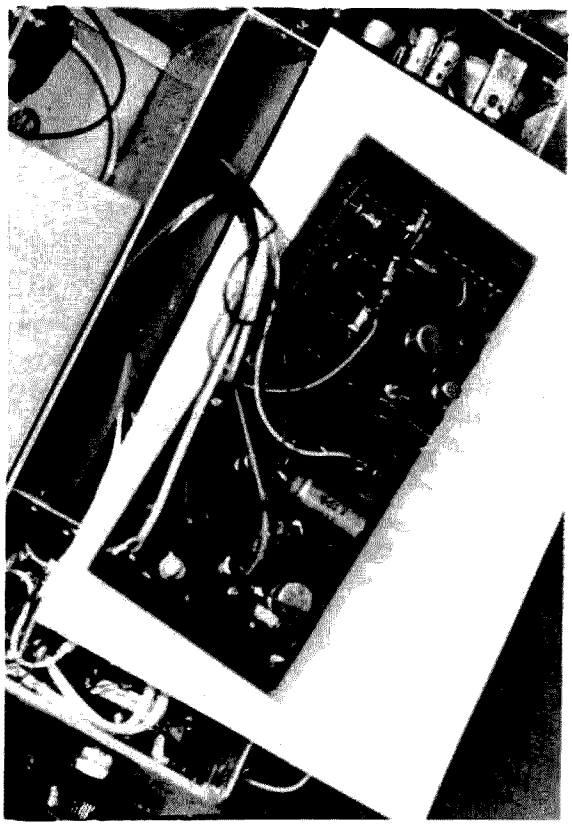


FIG. 13

÷*n* CIRCUIT



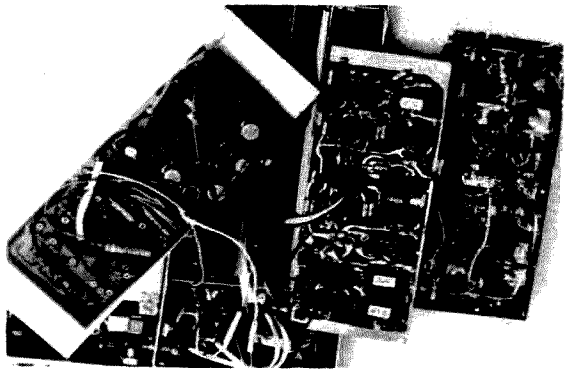
Closeup photo shows that it is practicable to get all the components of the phase detect and divide-by-500 circuit onto a single small card.

These switches provide great flexibility. With both switches in the *A* position, you transceive on frequency *A*. Similarly, with both in the *B* position you transceive on frequency *B*. Receive A and transmit *B*, receive *B* and transmit *A* are other combinations. It may sound complicated, but this system is very easy to use and a beginner can master it in seconds.

Once understanding of the method of controlling the synthesizer is complete, you can dream up all kinds of ways to control it. For example, it is simple to instantly select a preset channel, such as 146.94 (the national FM repeater output frequency) by throwing a toggle switch. This addition can be completely independent of other switch positions. And remote switching is easy because all control lines to the $\div n$ circuit handle only dc and simply are grounded in different combinations.

Figure 15a shows the master oscillator. It uses a field-effect transistor and has an automatic gain control arrangement for high stability. It is completely shielded and oven-controlled (Fig. 15b.). Asterisked components are thermally mounted to the oven box; the thermistor senses the oven temperature, and the other asterisked components deliver heat to it. In the original unit, the temperature control pot is mounted outside of the oven.

Referring to Fig. 15c, the 5 MHz low-level signal from the master oscillator is amplified in Q1 and Q2. Output from Q2 goes to the multiplier section and to squaring amplifier Q3, which drives the $\div 500$ circuit. Two outputs are used from the last flip-flop (I) 180 degrees out of phase. One goes to the search circuit, the other to the phase detector, below. The 10 kHz square wave is converted to a *spike* by C6—R9, as seen in waveforms *a* and *b* in Table II. Each positive spike turns Q5 on momentarily, charging C7 to +9V. Between spikes (waveform *c*), C7 discharges through R15, producing a sawtooth. (A linear sawtooth could be used instead of the nonlinear one used here, but the nonlinear waveform is actually beneficial in this system and is easier to generate.



Closeup photo shows the search board at left, the divide-by-n card and, at right, the mixer — multiplier assembly. The wall shield between those boards still in place are made from a conducting material deposited onto the fibrous board material; the close spacing increases the possibility of card-to-wall shorting, so a Mylar insulation sheet was attached over the surface of each of the shield walls.

Table I. Presets.

Frequency		÷n Ratio Reduction	A_1	B_1	C_1	D_1	A_2	B_2	C_2	D_2	A_3	B_3	C_3
0		0	0	0	0	0							
10		-1	1	0	0	0							
20		-2	0	1	0	0							
20		-2	1	1	0	0							
30		-3	0	0	1	0							
40		-4	1	0	1	0							
50		-5	0	1	1	0							
60		-6	1	1	1	0							
70	Steps,	-7	0	0	0	1							
80	kHz	-9	1	0	0	1							
0		0					0	0	0	0			
100		-10					1	0	0	0			
200		-20					0	1	0	0			
300		-30					1	1	0	0			
400		-40					0	0	1	0			
500		-50					1	0	1	0			
600		-60					0	1	1	0			
700		-70					1	1	1	0			
800		-80					0	0	0	1			
900		-90					1	0	0	1			
142		0									0	0	0
143		-100									1	0	0
144	XMT,	-200									0	1	0
145	MHz	-300									1	1	0
146		-400									0	0	1
147		-500									1	0	1
142		-100									1	0	0
143		-200									0	1	0
144	RCV,	-300									1	1	0
145	MHz	-400									0	0	1
146		-500									1	0	1
147		-600									0	1	1

Sampling pulses are produced from the ÷*n* output in a blocking oscillator (Q3) and fed to the gate of Q6 (waveform *d*). This pulse turns Q6 on briefly, charging or discharging C9 to the value of voltage on C7 at that instant. Capacitor C9 can only charge or discharge through Q6, so it holds that value of voltage until the next sampling pulse. Different ÷*n* outputs and the resulting voltages across C9 are shown in Fig. 18, *d* through *i*. Transistor Q7 is a source follower which drives the following circuitry at a low-impedance level, while maintaining a near-infinite load on C 9. The loop filter consists of R13, C10, R14, R16, diodes D5 and D6, and the rf bypasses at the VCO. The diodes effectively short out R16 for sudden large shifts in phase-detector output to speed the lockup process. For small changes, as seen when the loop is in lock, they have no effect.

A bias voltage is developed from the high-amplitude blocking oscillator output with D3 and D4. This bias is used to hold Q6 off between sampling pulses and to bias the varactor presteer input on the VCO.

Figure 16 shows the search circuit. It operates from the same two frequency inputs that the phase detector uses, except that its purpose is to detect *frequency* in-

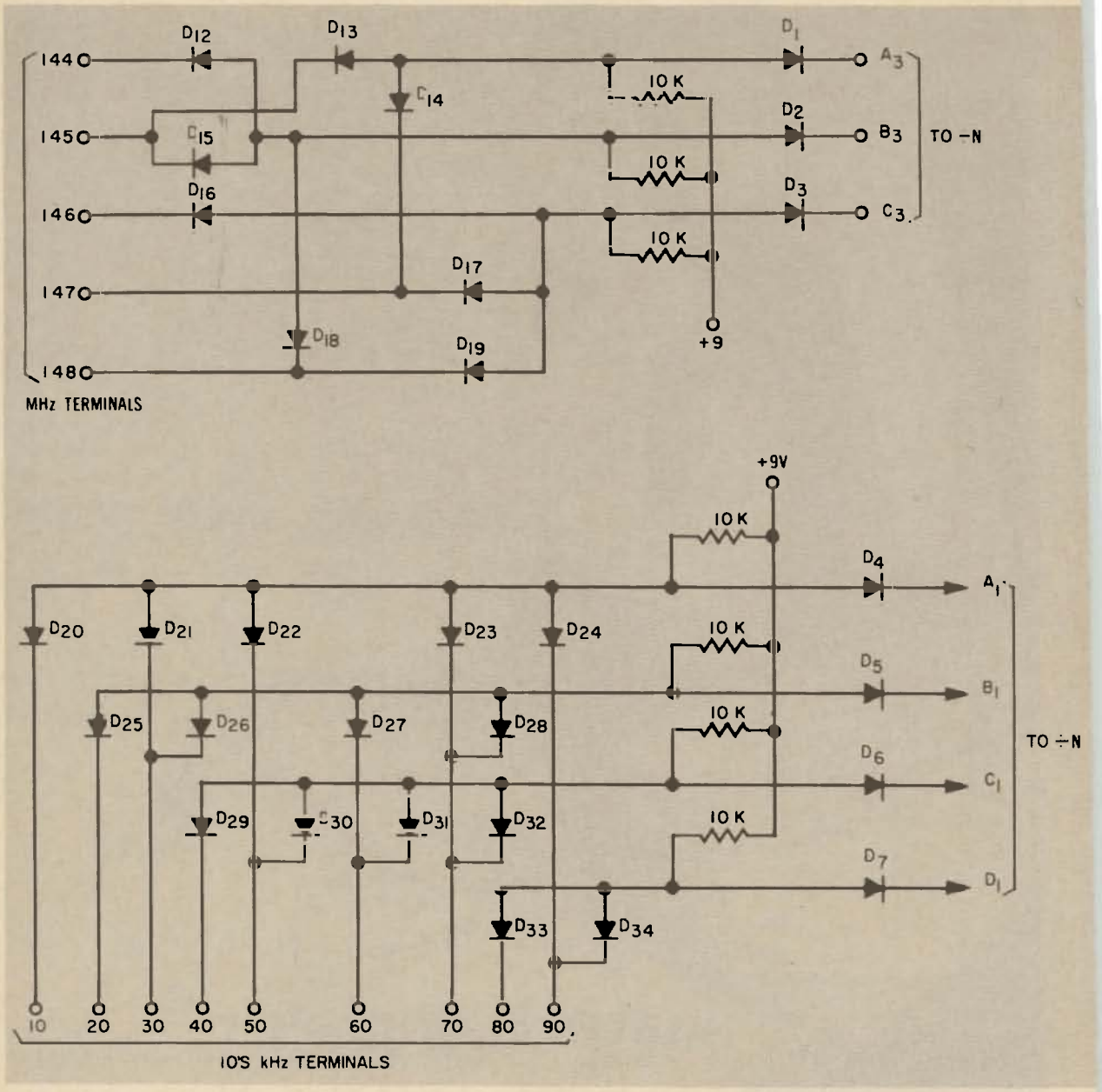
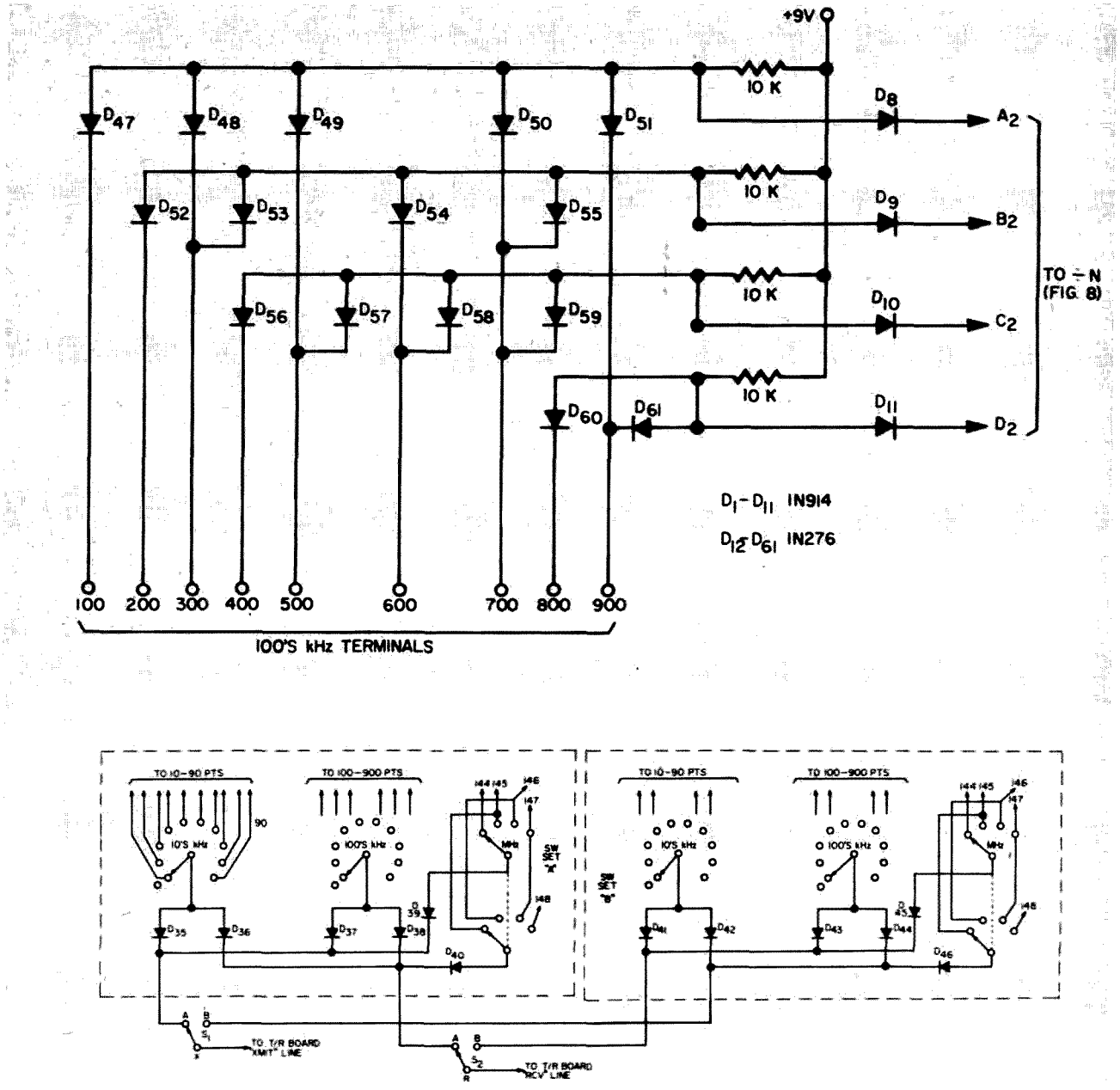


FIG. 14 *Frequency-switching with*

stead of *phase differences*, and to coarse-tune the VCO to the desired frequency, where the phase detector takes over. It accomplishes this by checking for pulse interlace; that is, to see that for every pulse received on one input there is *only one* pulse received at the other input. Obviously, if two pulses occur from one input during which time no pulse from the other input is received, the two pulse trains can't be of the same frequency.

Table III shows waveforms for the locked condition (*a*, *b*, *c*) where the comparator, consisting of gates BCGEHF, etc., does not produce any output pulses; and where the $\div n$ output is too high in fre-



diode matrices for rotary-switch utilization

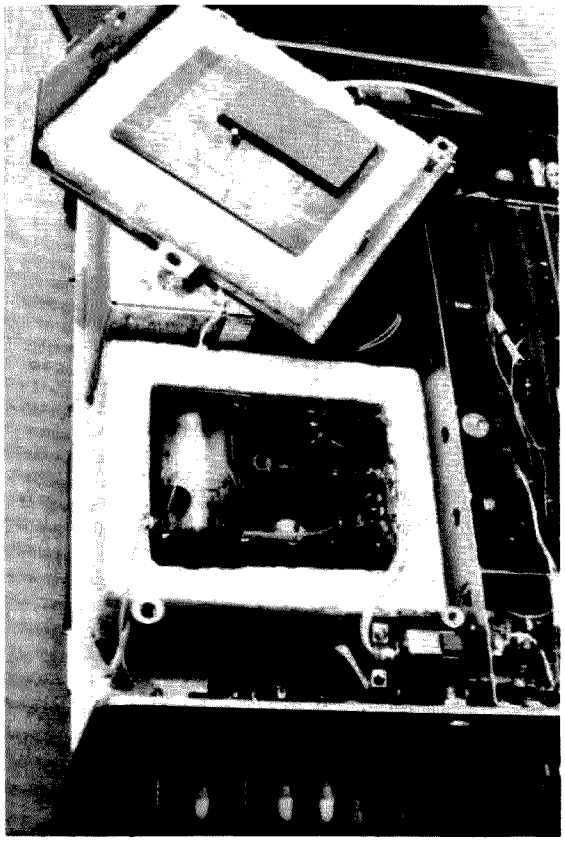
quency (*d*, *e*, *f*). When this case exists, gate H delivers pulses. When the $\div n$ output is too low in frequency, gate F puts out a series of pulses. When pulses come from H, Q6 and Q3 are pulsed on, producing a stepwise increase in voltage across C9. This voltage is summed with the voltage from the phase detector. As it rises, the VCO is tuned higher in frequency, which decreases the output frequency from the synthesizer mixer, decreasing the $\div n$ output frequency as desired. A correction in the opposite direction is accomplished by pulsing Q4 from gate F, decreasing the C9 charge in steps.

Gates I, J, and D do two things: they gate the transmitter off while the loop is searching (so you don't search while on the air) and they drive the out-of-lock indicator light (which tells you when something is wrong). The indicator normally flashes briefly between receive and transmit If anything goes wrong in the synthesizer the light is almost sure to indicate it.

Transistor Q8 is used as a presteering gate. Controlled by the T/R circuit, it is biased on in the receive mode, placing a positive voltage on the presteer input of the VCO. This voltage, adjusted by R16, reduces the voltage across varactor D4, increasing its capacitance and shifting the VCO tuning range down. When Q8 is off (in the transmit mode) the bias is allowed to swing to −10 volts, which reduces the capacitance of D4 to a minimum. Diode D9 regulates this bias level. Modulation is ac-coupled to the presteer input instead of the steer input so that it does not interfere with the operation of the loop. The 220 pF capacitor is an rf bypass. Modulation input impedance is 330K, and very little voltage swing is needed for 15 kHz deviation. Linearity for this level of deviation is excellent and hi-fi audio is possible.

Transistor Q2 is used to prevent a possible hangup condition of the loop, where the VCO gets tuned so low that the frequency supplied to the $\div n$ is beyond its counting capability. The $\div n$ would then start counting erratically, delivering too few pulses instead of too many, due to skipping pulses. The search circuit interprets this to mean that the $\div n$ output is too low instead of too high, so it steers the VCO in the wrong direction, perpetuating the situation. Luckily, the bias supply in the phase detector happens to depend upon a continuous supply of $\div n$ pulses, so that when this hangup condition occurs, it can be detected by a large drop in bias voltage. Transistor Q2 is normally biased off by this supply, but when the loop hangs up, bias collapses, so Q2 turns on and turns search transistor Q3 on in good *Rube Goldberg* fashion. Transistor Q3 charges C9 to maximum voltage, sweeping the VCO to the high end of its range, where normal lockup can take place. The entire process takes place in a few milliseconds. C3 causes a delay to make sure that Q3 turns on completely.

The oven assembly should be thermally isolated to the greatest extent possible. In the unit pictured, the crystal oven circuit is isolated from the remainder of the circuitry by means of a thick styrofoam surround. Shown in the oven are: the crystal (at left), voltage-controlled oscillator (in corner compartment), and 5 MHz oscillator with oven control circuit.



Shielding

Most of the circuits are susceptible to the high-level rf fields typically generated by an adjacent transmitter. The $\div n$ circuit is an efficient hash generator to nearby receivers at nearly any frequency. It is therefore important that most of the synthesizer circuits be shielded from the outside world as well as from each other. All leads should be filtered and bypassed with *RC* or *LC* circuits. Extra B+ bypasses in

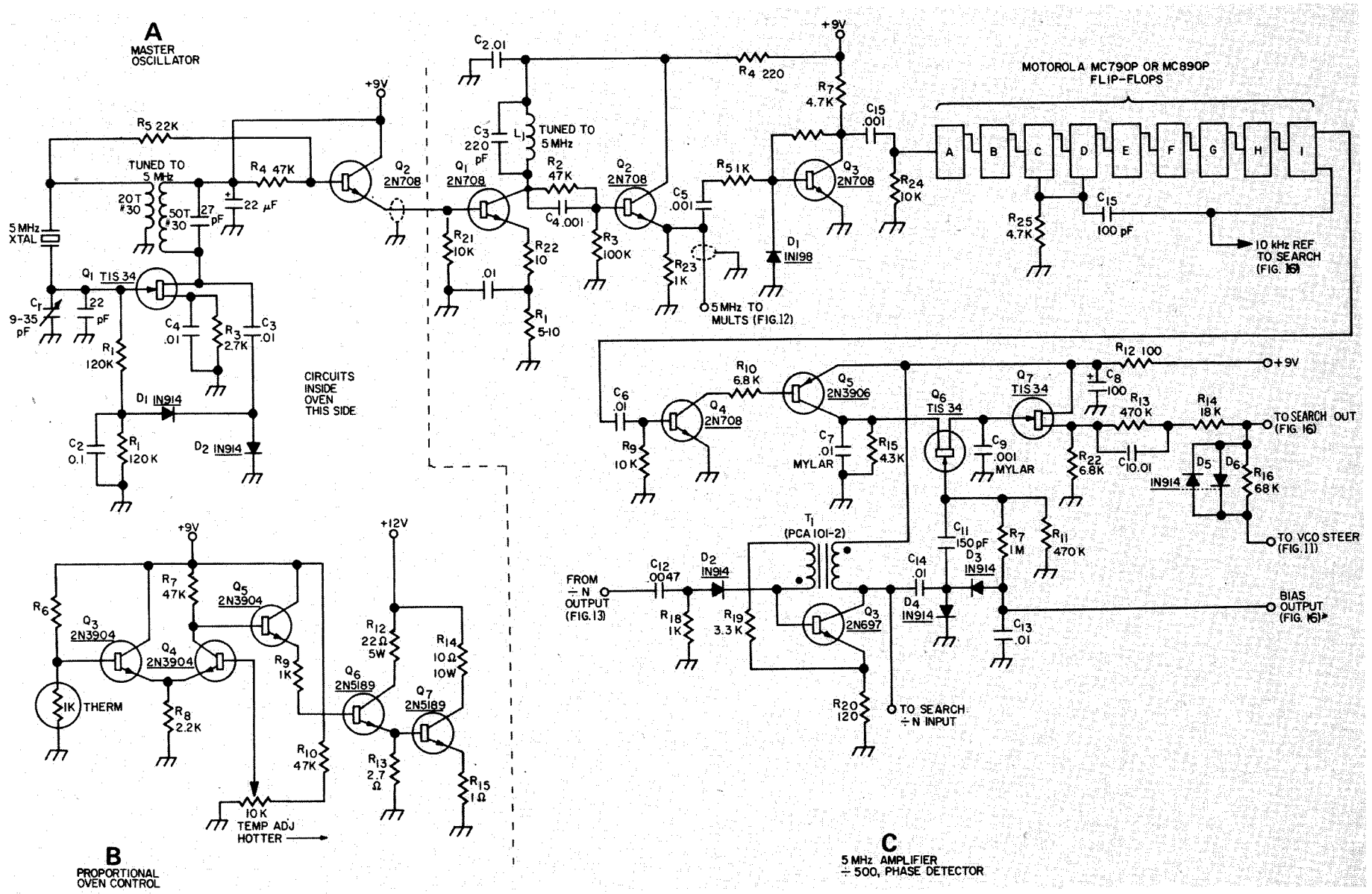


Fig. 15. Oscillator, 5 MHz amplifier, and oven control

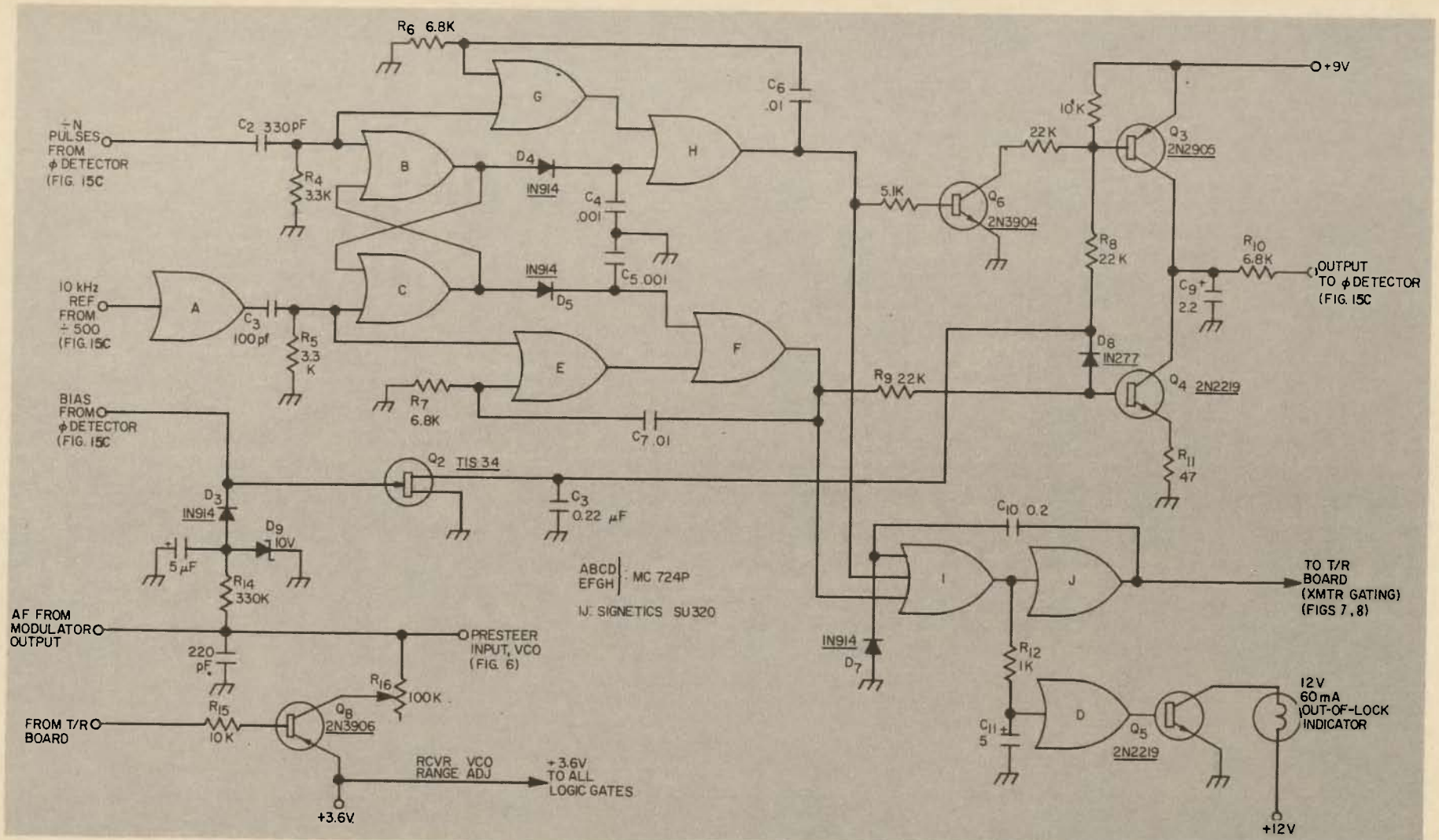


Fig. 16. Search, out-of-lock indicator, and presteer

Table II. Phase detector waveforms.

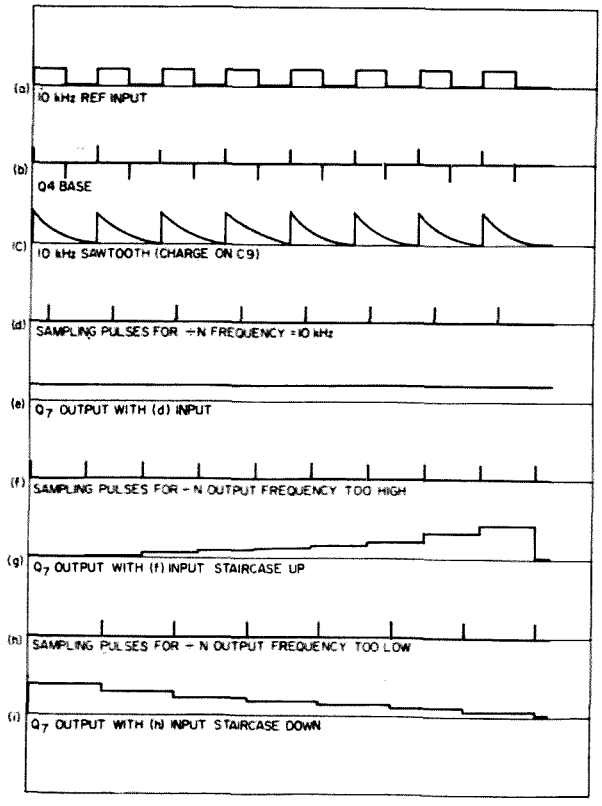
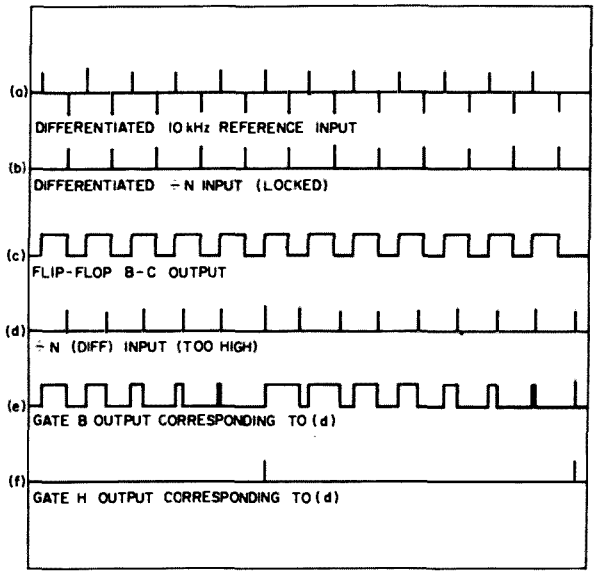


Table III. Search waveforms.



the system will be found helpful in various spots. The most insidious form of system trouble is when complex circuits interact in ways not anticipated; so make sure the circuits function as they should separately, and then combine them in sections. Test everything for proper function before making any attempt to close the loop. When the loop is out of lock, everything jumps at once, and it is truly enough to make a grown man cry. Usually, the only hope is to open the loop and check individual circuits. With experience you can read the signs and troubleshooting becomes just as easy as robbing Fort Knox.

Performance

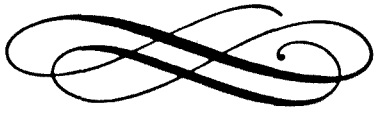
With a good master oscillator you can get counterlike frequency accuracy on all channels. The author's unit is accurate to better than plus or minus 20 Hz at two meters with a 20 minute warmup. Even without a warmup period, it is considerably better than most crystal-controlled rigs after stabilization.

Unlimited channel flexibility is a recurring pleasure that intensifies with time. Anyone who tells you that you are off frequency has just *got* to be from out of town! Even if you have a doubt, it takes only one quick zero-beating check against WWV to *guarantee* superaccuracy on all channels!

The big worry most people have about synthesizing frequencies is the potential spurious outputs. The author's unit was cheked on an H-P spectrum analyzer from 10 MHz to 2,000 GHz and found to be clean to –70 dB from carrier, excepting harmonics. And even at that level there was only a 5 MHz sideband pair, originating from the master oscillator. Adjacent 10 kHz sidebands couldn't be measured directly, but calculations based on the ripple level measured in the VCO feedback loop indicate them to be over 65 dB down. This figure is consistent with on-the-air observations.

It *is* worth the trouble. You must use a synthesized rig to appreciate it!

GILBERT BOELKE



And They'll All Wear Green . . .

The Annual St. Patrick's Day Swapfest, organized by the Midland Amateur Radio Club, is slated for March 14 and 15. Write MARC, Box 967, Midland TX 79701 for details.

ENCODING & DECODING

. . . a series of three related articles

PART I: Encoders for Subaudible, Tone-Burst, or Whistle-On Use

by John Gallegos W6ZCL
14646 Flatbush Ave.
Norwalk CA 90650

PART II: Tone Decoder for Remote Switching Applications

by Ken Sessions, Jr. K6MVH
73 Grove Ext.
Peterborough NH 03458

PART III: Setting Up the Tone-Burst System

by Les Cobb W6TEE
4124 Pasadena Ave.
Sacramento CA 95821

in FM REPEATERS

COMPLETE IN THIS ISSUE

Editor's Introduction;

An interesting and unforeseen problem developed as a result of the tremendous growth in popularity of FM repeaters: When two or more repeaters operate with overlapping coverage on the same input or output frequency, mobile operators occasionally find themselves triggering more than one repeater. The mobile operator who does so may thus cause interference by his unintentional keying of the repeater in a neighboring community.

As a rule, shifting the frequencies of one of the repeaters is no solution, because both relay stations will want to be on the nationally accepted standard (146.34 MHz input, 146.94 MHz output). Such standardization is a boon to the mobileer who has a limited supply of crystals and must travel across the country or from one area to another once in a while.

But there are workable solutions. More and more, repeaters in highly congested areas are going to a "tone-burst entry" approach or a "whistle-on" system of keying. With a whistle-on system, the control circuits are all at the repeater site. The repeater is never operative unless specifically activated by one of the users.

A broad whistle on the input frequency energizes a decoder at the repeater site, which in turn activates the automatic signal-relaying system. Typically, the repeater stays on, once activated, retransmitting the signals of all carriers on the input. When the traffic dies down a bit—that is, after a short period of no signals—the repeater shuts down again, and cannot be used unless someone deliberately calls for it by whistling on the input.

When multiple-repeater conditions are more severe, the tone-burst keying system is the more satisfactory solution. Here, a specific tone frequency—usually 1700 to 2000 Hz—must be present briefly at the outset of every transmission before a signal can be automatically relayed. In practice, all who intend to use the repeater will install simple audio oscillators into their transmitters, connecting them in such a way that the tone comes on briefly each time the transmitter is keyed. The tone, decoded at the receiver of the relay station, is used to activate the repeater— but only for the duration of a single carrier.

The first article in this series of three describes how whistle-on and tone-burst repeater systems are used and presents schematics of a simple oscillator suitable for use in whistle-on systems as well as a "microencoder" that can be adapted to either tone-burst entry or subaudible continuous-tone squelch systems. The second article in the series gives construction and theoretical details for a decoder ideal for use with either of the two single-tone oscillators of Part I. The third article, by Les Cobb, describes a network of tone-burst repeaters, and includes information on how to set up a tone-burst oscillator in a mobile transmitter and how to connect a decoder into a repeater system. Together, these three articles provide complete information for converting an existing repeater facility to tone access.

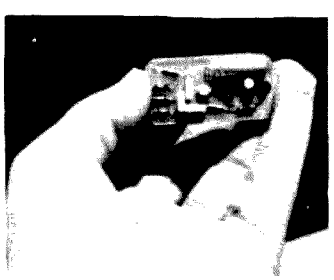
Part I: *by John Gallegos W6ZCL*

Encoders for Subaudible, Tone-Burst, or Whistle-On Use

The FCC sanctions the use of semicontrol techniques such as continuous-tone carrier squelch systems (very low frequency tones accompanying all carriers) and single-tone (tone-burst entry or whistle-on access) in applications where limited access to a remote station or a repeater is desirable. The W6FNO repeater in Southern California went one step further, and the result is a repeater that is fully compatible with two-way nonrepeater operation taking place on the input channel.

In many ways, the W6FNO repeater at Radio Ranch could serve as a model installation: The repeater stands ready for use 24 hours a day and is never shut down where it cannot be accessed by a station on the input frequency. On the other hand, the repeater will shut itself off if a three-minute period elapses with no signals on the input. Sounds a little contradictory, but it isn't—not really. The W6FNO repeater was an experiment to test the concept of subcontrol, i.e., limited control of the repeater from the actual frequency of operation.

The repeater is equipped with two timers. The first timer is a transmission-limiting device: when the input carrier exceeds three minutes duration, B+ is removed from the transmitter final; and it can only be reapplied after the input carrier drops out momentarily. The second timer removes the transmitter B+ also. But in this case, the timer is activated by the absence of an input signal. Since the shutdown is only B+ removal, the repeater is ready to be activated immediately upon application of the proper signal, which in this case is nothing more than a shrill whistle.



Barely more than a thumb's width, the W6ZCL phase-shift oscillator is small enough to be packaged within the case of almost any commercially available hand-held transceiver.

The W6FNO repeater is a "talkback" type, as opposed to a "prime" repeater. A talkback repeater uses a national FM channel as the input frequency and a nonactive channel as the output. A prime repeater uses a nonactive channel as the input and an active, popular frequency as the output. The popular 146.34-to-146.94 repeaters across the country are primes. If the frequencies were reversed, they would be talkbacks.

The active FM channel for direct nonrepeater operation in the W6FNO territory is 146.82 MHz, which also serves as the repeater input. The repeater output frequency is not used at all except by stations who want to hear what's going through the repeater. When two stations are conversing on the FM channel, the repeater is not even a part of the operation unless one of the operators wants it to be (as for instance when the copy gets rough).

When a user wants to monitor the active 146.82 channel, but he is too far away from the area of activity to hear the stations, he merely puts a carrier on the channel and whistles into the microphone. Instantly the repeater comes on, regardless of the time of day or night, and the user finds himself right in the middle of the action. The only

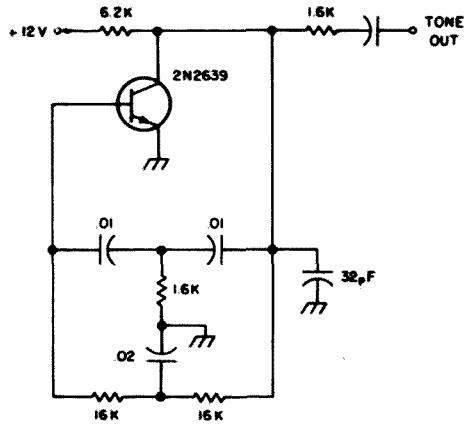


Fig. 1-1. Single-transistor tone oscillator for tone-burst or whistle-on use produces 1750 Hz at sufficient amplitude for most transmitters.

difference is that he hears the 146.82 action on some other channel.

The decoder at the repeater site that provides the turn-on function is nothing more than a simple frequency-to-dc converter such as the semiconductor decoder shown in the second article of this three-part series (included with this issue). This device is set to respond to as broad a range of frequencies as possible without being energized from ordinary conversations.

Even though the W6FNO decoder was set to respond to a wide frequency range, a few users found it difficult to key the repeater on by whistling. Perhaps their audio levels were not quite what they should have been to reproduce properly the required tone (1750 Hz), or perhaps they were simply not proficient whistlers. At any rate, I decided to install a simple automatic whistler in each of my transmitters.

The circuit is the epitome of simplicity: a single-transistor oscillator using a twin-T feedback network. As can be seen from the circuit of Fig. 1-1, a few minutes and a good junkbox are all that is required.

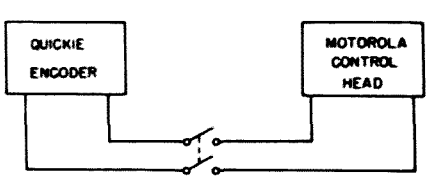


Fig. 1-2. A momentary-contact switch can be used as shown to interconnect the encoder audio into the mike line at the control head for whistle-on applications.

I didn't connect the whistler so that it would go on with each transmission. Not only would this have defeated the purpose of the repeater's automatic-off function, but it would have given my signal the unpleasant characteristic of a squeal at the outset of each transmission. Instead, I connected the device into the transmitter so that it is energized by pressing a momentary-contact switch on the control head. Figure 1-2 shows how the oscillator is interconnected into my Motorola mobile unit.

The oscillator circuit shown in Fig. 1-1 works for tone-burst entry applications, too, where the tone frequency tolerances are not particularly critical. But the interconnection would have to be a little different from that shown in Fig. 1-2. For tone-burst operation, remember, the audio note must appear for a short period every time the transmitter is keyed. A timing circuit for accomplishing this is shown in Part 3 of this series, Les Cobb's article entitled "Setting Up the Tone-Burst System."

Where the tone frequency is critically set, decoder instability is intolerable and whistling won't quite cut the mustard. For such applications, the encoder requirements become quite stringent. But it is possible to build a highly stable encoder unit with a minimum of parts. The circuit described below, for example, represents a very versatile transistorized encoder that can be built small enough to use with hand-held transceivers, yet stable enough for the most demanding applications normally associated with FM two-way communications. Because of its tiny size, I call the device a "microencoder."

A particularly attractive feature of the microencoder is the fact that it can be used for either continuous-tone squelch (commonly known in these parts as PL, for Private Line), or for tone-burst entry. As noted in the editor's introduction to this series, a continuous-tone squelch scheme utilizes a subaudible very low-frequency note, whereas the single-tone method depends on generation of a fairly high-frequency note. Most low-frequency encoders require vibrating reeds for stability; the one described here is a notable exception.

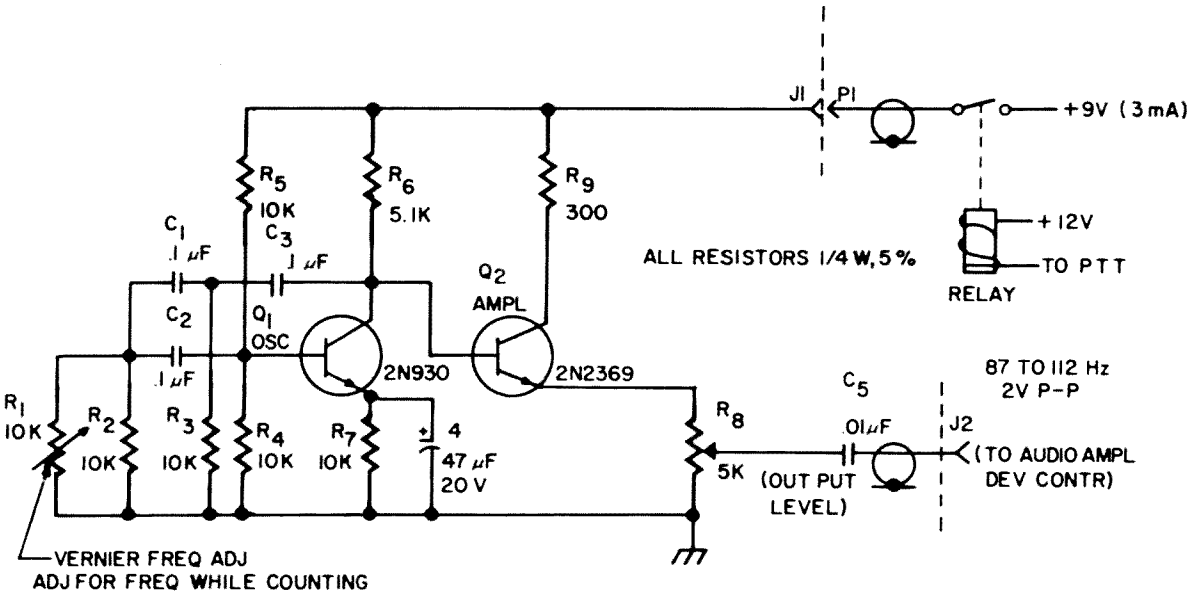


Fig. 1-3. Schematic diagram shows basic circuit as used in a continuous-tone-squelch repeater access system. Parts values shown are not applicable to single-tone encoder applications (see text).

Figure 1-3 is the schematic diagram for the unit, which is essentially a phase-shift oscillator coupled into an emitter follower. Since the power consumption of the oscillator circuit is so low, a standard 9V transistor-radio battery will provide an ideal power source. At full output, the oscillator draws no more than about 3 mA.

Table I. Parts Lists for CTS and Single-Tone Systems

Component	87—112 Hz range	1750 Hz
R1	10 pot (multiturn)	50K pot (multiturn)
R2, 3, 5	10K	47K
R4	10K	22K
R5	10K	47K
R6	5.1K	5.1K
R7	5K pot (multiturn)	4.7K 5K pot (multiturn)
R8	300Ω	300Ω
R9	0.1μF	0.001 μF
C1, 2, 3	47 μF, 20V tantalum	47 μF, 20V tantalum
C4		1 μF
C5	0.01 μF	tantalum
Q1	2N930	2N930
Q2	2N2369	2N2369

Table I shows two complete parts lists. The application of the encoder (continuous-tone squelch or tone-burst entry) will determine the parts selection for your particular use.

The very small size and the apparent simplicity of the microencoder might logically lead you to suspect its performance. But these factors notwithstanding, the device can produce a very healthy looking sine wave, as can be seen from the photo of **Fig.1-4**. Laboratory temperature cycling tests on the three units that I built indicate that the tone output will remain stable and will not drift more than 0.5 Hz over the range of 25-60°C. My units were built using disc ceramic capacitors, incidentally, substitution of Mylar capacitors for C1, C2, and C3 will undoubtedly result in even better temperature stability.

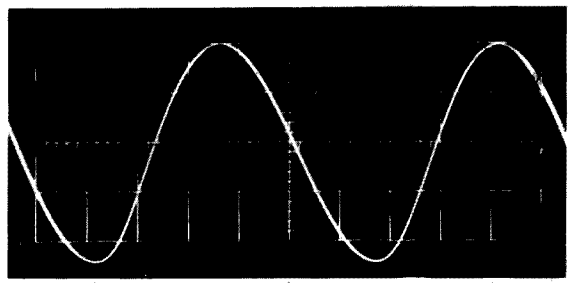


Fig. 1-4. Scope trace shows the sine wave obtained with the author's encoder unit. Increments shown are 2 msec per centimeter for the horizontal scan and 500 mV per centimeter for the vertical scale.

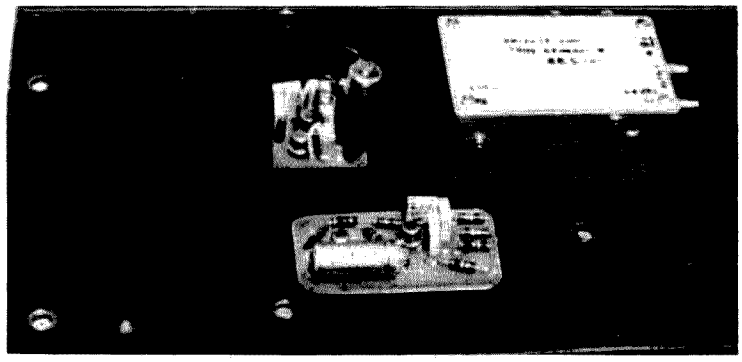


Photo shows three separate packaging schemes: printed-circuit layout; "cordwood" technique, and the "crystal-can" method, using a conventional Pomona Electronics miniature mounting box.

The schematic shows transistor Q1 to be a 2N930, but this type was chosen arbitrarily because it is something I happened to have "kicking around." Actually, any good NPN will suffice, as long as it is a type with a *beta* of 100 or so. The transistor used for the emitter follower is even less critical, and can be effectively duplicated with just about anything in the junkbox that has the same polarity.

As a continuous-tone-squelch encoder, the one mounted in my 41V has proved quite capable of keeping me communicating through the local toned repeater, which uses a GE KT-5 decoder to open the squelch with an input of 88.5 Hz. Another of the units, built from the other parts list, of course, very efficiently provides me with a 1750 Hz tone burst when I operate through the W6FNO repeater.

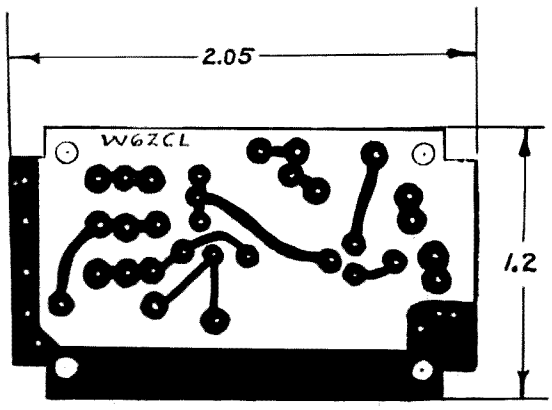


Fig. 1-5. Actual-size reproduction of printed-circuit layout. The copper side of the board is shown; components all mount from far side. (There is no copper on the component side.)

Figure 1-5 is a circuit board layout shown actual size. **Figure 1-5** is for those of you who intend to do the job up first class with printed-circuit wiring. The printed-circuit version looks sharper, of course, and it has the added advantage of ending up with a slimmer overall profile. The layout shown in **Fig. 1-6**, however, is perfectly satisfactory for "brass-board" models. This version requires nothing more than a few holes and some standoff terminals on a flat piece of almost anything.

The dimensions of the boards are suitable for mounting the completed unit inside a Pomona Electronics Model 2417 shielded box ($1.50 at practically any self-respecting electronic sales outlet). The low-frequency version that I am using is mounted on the inside rear chassis wall of my mobile 41V,

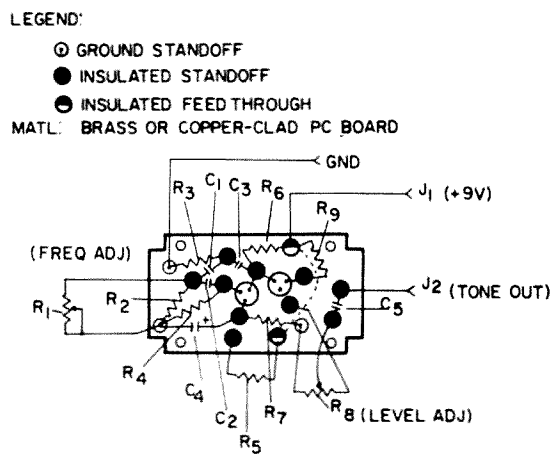


Fig. 1-6. Wired-board layout was designed for use with Sealectro push-in Teflon standoffs and ground terminals. Transistors can be held in place by TO-18 heatsinks. (Heatsinking is actually unnecessary. The cases of the transistors are hot and must be insulated from ground; the heatsinks perform this job by virtue of their anodized finish.)

immediately above the transmit crystals. I use miniature coax to apply the dc supply voltage (9V) and to carry the 88.5 Hz signal to the deviation control potentiometer through a 500 kΩ resistor, as shown in Fig. 1-7. If space is not available in the radio to mount the Pomona box, the printed-circuit board itself can be mounted in any available underchassis spot. The two variable resistors can be replaced without detriment by fixed resistors after the proper values have been

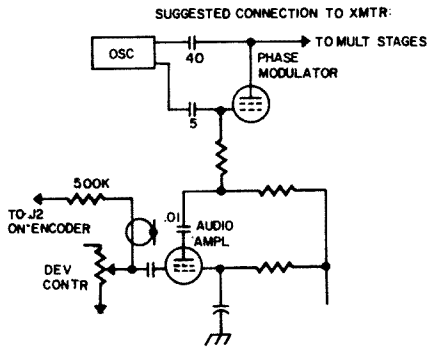


Fig. 1-7. Schematic showing manner in which the low-frequency version of the phase-shift oscillator can be tied into the transmitter.

determined for your particular frequency and output-voltage level. But potentiometers are handy if you have the space. If you *can* use them, I suggest the use of the miniature multiturn devices (Bourns *Trimpots*), because of the vernier tuning they afford.

The parts lists shown in Table I cover the continuous-tone-squelch range of 87–112 Hz and the single-tone frequency of 1750 Hz. For those whose requirements are not met by either of these sets of values, the frequency of the encoder may be calculated from the equation

$$f = \frac{1}{2\pi\sqrt{6RC}} \qquad \frac{0.085}{RC}$$

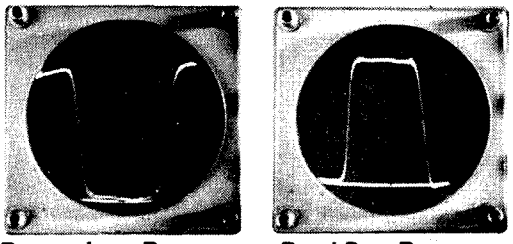
If the single-tone version is used rather than the continuous-tone-squelch version, the audio need not be coupled to the transmitter as shown in Fig. 1-7. At these higher frequencies, it is practicable and convenient to simply mount the encoder unit inside the control head and connect the audio output lead from the oscillator directly onto the mike line. If you choose to adopt this method, just connect a 200Ω resistor in series with the tone oscillator output lead before attaching it to the carbon mike pin on the control head connector.

If the local repeater is the whistle-on variety (rather than tone-burst entry), you might also find it convenient to run the audio lead through a single-pole switch mounted on the control head. In this way, you can switch the tone on whenever you want it, and keep it out of the circuit the rest of the time. (A whistle-on repeater stays on after the tone is applied for a few milliseconds, and does not drop off the air until several minutes after the repeater is not occupied.)

For tone-burst entry applications, the timer circuit described in Part III will prove very worthwhile. With the addition of this simple timer, the oscillator can be made to key on briefly with each initiation of the push-to-talk circuit. (Again, a tone-burst-entry system requires a short fixed-frequency tone to accompany each incoming signal to be repeated.)

. . . W6ZCL■

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Part II: *by Ken Sessions, Jr. K6MVH*

Tone Decoder for Remote Switching Applications

The most critical element of a tone-access system is the decoder. When some problem exists in the encoder, or when the encoder frequency shifts a bit or when the encoding level goes up too high or down too low, the control operator can solve the problem with a few local adjustments. But when the decoder starts acting up, the impact can be a great deal more severe: In the first place, the decoder is installed at the repeater site, which is, more often than not, situated atop some remote mountain peak—miles (and sometimes hours) from physical accessibility. Second, while an encoder malfunction affects one individual's operation, a decoder problem affects the operation of every user of the repeater. Thus, care in building and sound conservatism in design are paramount considerations in deploying a tone control scheme.

I have had occasion to use many decoders during my days of remote control and repeater operation—some homebrew, some commercial. (Virtually every aspect of remote control involves the installation of a tone decoder somewhere along the way. And I can truthfully say that I have never come across a circuit that offered performance superiority over the one shown in **Fig. 2-1.**

I hasten to add that I can lay no claims as to design, for the circuit illustrated was conceived, built, debugged, and perfected by Bob Mueller (K6ASK), of Alhambra, California. Nor is this the first time the circuit has been published. I have incorporated copies of the circuit in past articles dealing with remote control of telephones, function selection in repeaters, and coded signaling for selective-call applications. It simply is a good sound circuit and can be applied wherever there exists a need to perform a switching function in one place by radio command from another place.

Decoder Requirements

The response curve of the decoder must be selective enough to preclude the possibility of off-frequency signals triggering the system, yet broad enough to allow decoding under a variety of input signal conditions.

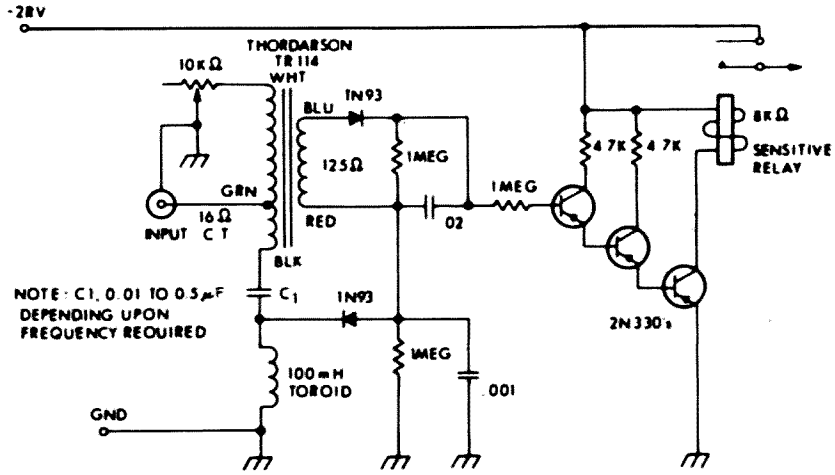


Fig. 2-1 Single-tone decoder.

Ideally, a control should be available so that the threshold sensitivity of the decoder could be adjusted.

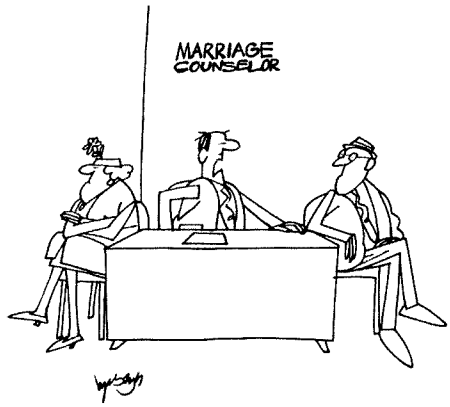
Adjustment of the input sensitivity accomplishes the effect of narrowing or broadening the spectral response of the device. At the least sensitive setting, the decoder has an input bandwidth of about 50 Hz. As the series resistance to the input of the transformer is decreased, the bandwidth widens. In the most sensitive position, the decoder will respond to a bandwidth that includes random noises and high-pitched voices. Thus, the decoder should fulfill the requirements of the whistle-on crowd as well as the more critical needs of the tone-burst fans.

The frequency of the decoder, using the values shown in the schematic, is 2300 Hz. This frequency can be shifted by the expedient of changing the value of capacitor C1. The 2300 Hz is fully appropriate for tone-burst applications, where voice tripping is to be avoided and whistle-on use discouraged. (The frequency is high enough to make whistling a difficult method of access.) It should be reemphasized, however, that whistle-on use of this decoder is possible—using the values shown—by simple adjustment of the sensitivity control of the input transformer.

Interconnection

The simplest part of getting a tone-access system to work is the interconnection of the decoder itself. All you have to do is provide the proper power to drive the transistors and relay, then connect the speaker audio from the repeater receiver to the low-impedance input of the decoder. After that, it is simply a matter of making a few adjustments with respect to level (at the decoder input and at the receiver output). When the controls have been properly set, an incoming tone of the correct frequency will cause the plate relay in the decoder to close. Use of the relay's contacts is a matter that is best left to the judgment of the repeater owners. If you're short of ideas, however, you might just read on. Part III tells how to go about setting up a complete tone-burst-entry repeater system. And the decoder described here will fill the bill nicely for that application.

. . . K6MVH■



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Part III: *by Les Cobb W6TEE*

Setting Up the Tone-Burst System

Among the various techniques for selective control of remote devices, including repeaters, one of the simplest is tone-burst keying. This method consists of a short burst of a specific audio tone automatically sent at the start of a transmission. In a repeater application, a burst detector (see Part II of this three-article series) is used in conjunction with the carrier-operated relay to activate the repeater transmitter upon reception of the proper burst frequency, and to hold it on as long as the incoming carrier is present.

The simplicity and versatility of tone-burst keying should not be overlooked where a simple control or selection function, not related to primary control, is required. As an example, the number of 146.34-to-146.94 repeaters on the air or being built in Northern California and Nevada was such that it became obvious that overlapping input coverage was going to cause unintentional keying and interference to adjacent machines. To obviate this, a tone-burst frequency allocation plan was agreed upon. As shown in **Fig. 3-1**, the plan covers four repeaters and one remote base station with a burst-protected 146.94 receiver.

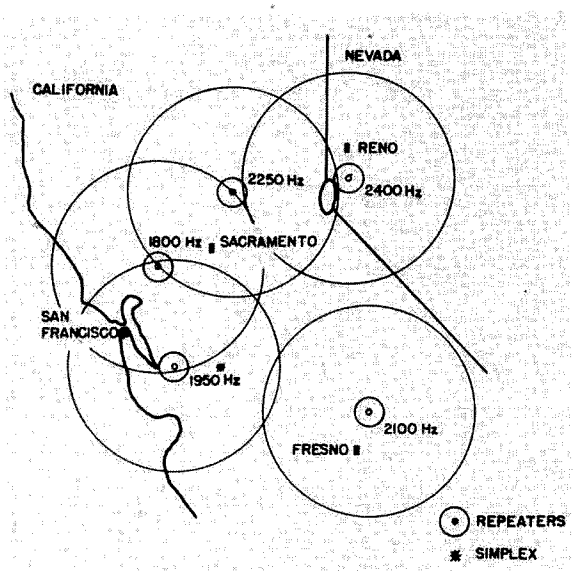


Fig. 3-1. Tone-burst entry plan—34/94 repeaters—No. Calif./Nevada.

While it is admitted that the tone-burst approach does not solve all of the problems associated with overlapping repeater coverage, it certainly tends to minimize them by permitting the users to call for only the particular repeater needed for a given two-way communication exchange.

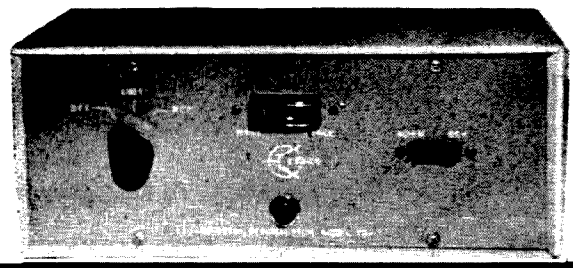
If tone-burst entry is used on open repeaters on the nationally adopted frequency of 146.34, some semblance of standardization should be maintained to give travelers some hope of universal access capability. Partly because of the abundance of Motorola equipment, the frequencies long considered standard by Motorola are most common in amateur use. The following frequencies are stock outputs for the Motorola P-9301A encoder: 1800, 1950, 2100, 2250, and 2400 Hz.

In amateur service, there are many tone-burst systems operating in the 1700 to 1800 Hz range, but these lower frequencies might better be reserved for whistle-on use because of the ease with which they can be orally reproduced.

For those wishing to use commercial equipment, the Motorola P-9301A encoder and P-9303 decoder are available on the surplus market. More recently, the Motorola SP-1005-TAAE solid-state under-dash oscillator has become available. This unit has a selector switch and can generate all tones from 1800 to 2400 Hz, in 150 Hz increments.

But if you've a mind to build up the encoders and decoders, the circuits shown in

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the accompanying articles should do nicely. That leaves only the problem of interconnection.

When an encoder such as the one depicted in Part I is used, some means must be employed to limit the oscillator's output to no more than a half-second or so with each keying of the transmitter. To accomplish this, the timing circuit shown in **Fig. 3-2** was developed by K6GUC. In his approach, the 12V supply for the encoder must be keyed on and off with the transmitter.

At the repeater site, some wiring must be done at the decoder to keep the transmitter locked on for the duration of a carrier, even though the tone itself drops out. **Figure 3-3** illustrates how this might be easily achieved. The repeater control relay (K2) should be fairly husky; it can be driven directly by the decoder relay (K1). It is not wise to derive the K2 switching functions by wiring the contacts of K1 directly, because K1's contacts are likely to be of a delicate nature. K1 is a sensitive, current-operated relay and its contacts are best used for no greater requirement than to control a heavy-duty dc relay.

. . . W6TEE ■

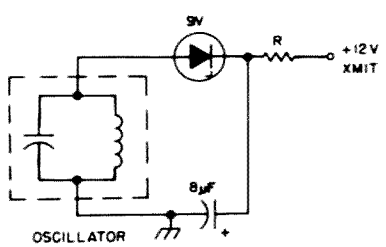


Fig. 3-2. K6GUC tone-burst timer.

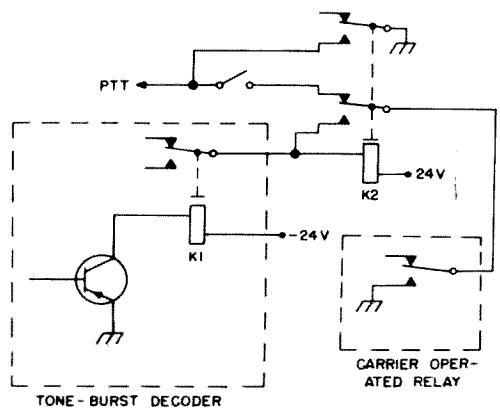


Fig. 3-3. Burst decoder and carrier-operated relay connections.

HOW TO VISIT FOREIGN COUNTRIES



by Wayne Green W2NSD/1

A reader, about to make a trip abroad, asked for hints on how to get in touch with amateurs in foreign countries. As one who has done this sort of thing a lot, I think I have some helpful ideas.

First, by way of preparation, I devote several weeks to intensive activity on 20 meters. I look for contacts in the countries I am about to visit, and I find that these contacts almost invariably lead to interesting invitations to dinner and sightseeing. They also lead to my getting to meet many more of the local amateurs.

I follow up my contacts with a QSL card and a letter giving my itinerary in detail for my trip. If I am going to be met at the airport, I try to make sure that my DX contact knows just what flight I will be on, and I let him know immediately of any plan changes. I realize that he will be taking a lot of trouble on his end, rearranging his work schedule, his family plans, and setting up meetings with friends, so I try to be as considerate as I can. If I am not traveling a long distance, I phone ahead and let him know that I am on schedule.

It is well worth while to write ahead to the secretary of the national amateur radio club of the country you are going to visit. The club officer can arrange for you to meet a representative and this often leads to introductions to local amateurs, visits to club meetings, and even getting in touch with someone to stay with on occasion.

If you are interested in operating, the club can often help you to get an operating permit and may even have a club station available for you. If you use the call letters of the station, often no permit is required and all you have to do is just sit down and operate. I have done this from dozens of countries. Always offer to take care of the QSLing brought on by your operating.

Rare Countries

There are very few rare countries where there is not even one active amateur. If you are going to DXpedition to a completely inactive country, you will have to bring

along your own equipment, obviously. This is expensive and difficult, as any reading of articles by DXpeditioners makes very clear. For my part I avoid countries of this rarity and try and stick to those that have at least one active amateur.

I have found that the amateurs in rare countries are all too happy to have me visit and sit down for a day or so at their rigs and rack up a few thousand contacts. The pressure for contacts and more contacts every time they get on the air gets to be depressing after a while, and they tend to limit their operating time or keep out of the American phone band. In just a couple of days I can take a lot of this pressure off.

English is the native language for very few DX operators, so I find that under QRM conditions I can make contacts many times as fast as can the local op. Knowing English, I can sort out call letters quickly from the mass of calling stations.

Even when I visit relatively common countries I find that I get pileups. When operating from 5Z4ERR in Nairobi I gave contacts to a lot of the lower power stations that normally miss out on DX. Further, I found that I was in great demand by mobile ops by the dozens. My system of working right down to the weakest signal in each call area made it possible to work even the flea-power stations.

When I visited FK8 I found that the country was in great demand because almost all of the local ops spoke only French. The FK8 ops appreciated my getting a few thousand W's off their backs by giving them a contact with their country. Ditto FO8 in Tahiti.

Your trips abroad will be infinitely more fun if you make arrangements to visit amateurs. They will wine and dine you, show you their city and country, just as you would them. They will offer to put you up and they will get in touch with friends in the cities along your path. You will have an opportunity to explain the U.S. to them in a way that no Hollywood movie has ever done. You will also have a chance to find out anything about their country that you want to know, just for the asking. And they will love you for being interested enough to ask.

. . . W2NSD ■

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The DX-35 REVISITED

A few tips for modernizing the old standby

Many of us, when we first started in amateur radio as a Novice, purchased the Heathkit DX-35. This transmitter was capable of 75W input and was running quite hard to achieve this power level. The oscillator and final were both keyed, so with certain crystals there was an inherent chirp.

We were contemplating the use of the DX-35 as a CW exciter for a kilowatt linear. Our main goal was to modify the circuitry of the DX-35 to improve the efficiency and eliminate the chirp.

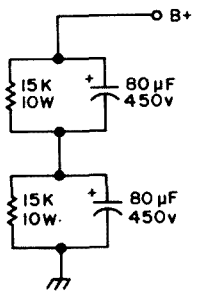


Fig. 1. Existing 20 µF capacitors can be replaced by 80 µF cans to up the filtering to 40 µF total.

The first modifications to be made were in the B+ filtering circuit. Normally, two 20 µF, 450V capacitors were being used in series to give a total of 10 µF, 900V of filtering. We replaced these paper capacitors with can type 80 µF, 450V capacitors to give a total of 40 µF for filtering (See **Fig. 1**). Appropriate holes were cut in the chassis so as to mount the can type capacitors. One of the capacitors will require an insulating mount to isolate it from the chassis due to the fact that these capacitors are in series. The original equalizing resistors (15 kΩ, 10W) were retained and placed in parallel with the new capacitors.

The 5U4 rectifier was replaced with a 1N1239 silicon rectifier unit. This solid state rectifier plugs directly in the socket of the 5U4. (An alternate method is to build up your own replacement in the base of a broken 5U4.) You conserve on power transformer drain through the use of this because the 5V filament source is no longer necessary. The solid state rectifier will also provide an increase in total plate voltage.

We had received reports of chirp using the DX-35 as a barefoot transmitter. Of course this would be undesirable when using the linear. A considerable voltage drop was observed on the oscillator plate when the transmitter was keyed. Also, both the final and oscillator are keyed. We removed the cathode grounding lead of the oscillator from the front panel keying jack and ran this to a single-pole toggle switch that was also

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A4022	2N1546	Motorola MP1546 High Reliability 90 Watts.	1.00
A4023	#108	Motorola or Delco Similar to 2N1100 40 Watts.	3/2.00
A4024	2N3567	Fairchild NPN Silicon General Purpose	5/1.00
A4025	MADT	Sprague.	4/1.00
A4027	2N706A	Sylvania NPN Silicon VHF 1 Watt	5/1.00
A4028	2N1011	Motorola PNP Germanium Power 35 Watts	3/2.00

Diodes

A4005	1N629	Hughes PIV 175, 30 ma	8/1.00
A4006	1N1200	Sylvania PIV 100, 70 ma . . .	8/1.00
A4007	1N2326	RCA Rectifier PIV 200, 100 ma	5/1.00
A4008	1N3195	RCA Rectifier PIV 600, 500 ma	10/1.00
A4009	1N3255	RCA Rectifier PIV 600, 500 ma	10/1.00
A4030	1N541		
A4032	1N3208	Motorola Silicon Rectifier 50 Volts, 15 Amps	3/1.00
A4034	1N4785	RCA	
A4050	1N2071	Sylvania Bullet Diode PIV 600, 750 ma	8/1.00

Zener Diodes

A4010	1N751A	5.1 Volts, 400 mw	5/1.00
A4011	1N3039A	62 Volts, 1 Watt	3/1.00
A4012	1N3822	3.6 Volts, 1 Watt	5/1.00
A4013	1N3000B	62 Volts, 10 Watts	2/1.00
A4014	1N3048B	150 Volts, 1 Watt	3/1.00
A4015	¼M3.0	3 Volts, ½ Watt	4/1.00
A4029	1N429	5.6 Volts, 1 Watt	4/1.00
A4038	1N961B		
A4040	1N3048	150 Volts, 1.7 ma (Matched pair)	.75

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mounted on the front panel. This switch was wired so as to ground the oscillator cathode and allow the oscillator to run at all times when the final was keyed. Less chirp was noticed but there was still a small amount present.

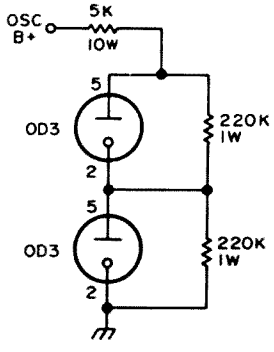


Fig. 2. The 220 kΩ resistors across the series regulators help to equalize the oscillator voltage distribution.

The next step was to get rid of the voltage variation on the oscillator that was present when keying. Two OD3 regulator diodes were placed in series to give a 300V regulation level. Resistors (220 kΩ, 1W) are paralleled across the OD3's to equalize the voltage and a 5 kΩ, 10W current-limiting resistor was placed in series with the OD3's (**Fig. 2**). This assembly was inserted between the oscillator B+ and chassis ground. The voltage on the 12BY7 oscillator now remains at 300V during the keying sequence, and the chirp is eliminated.

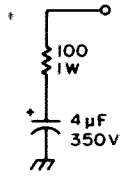
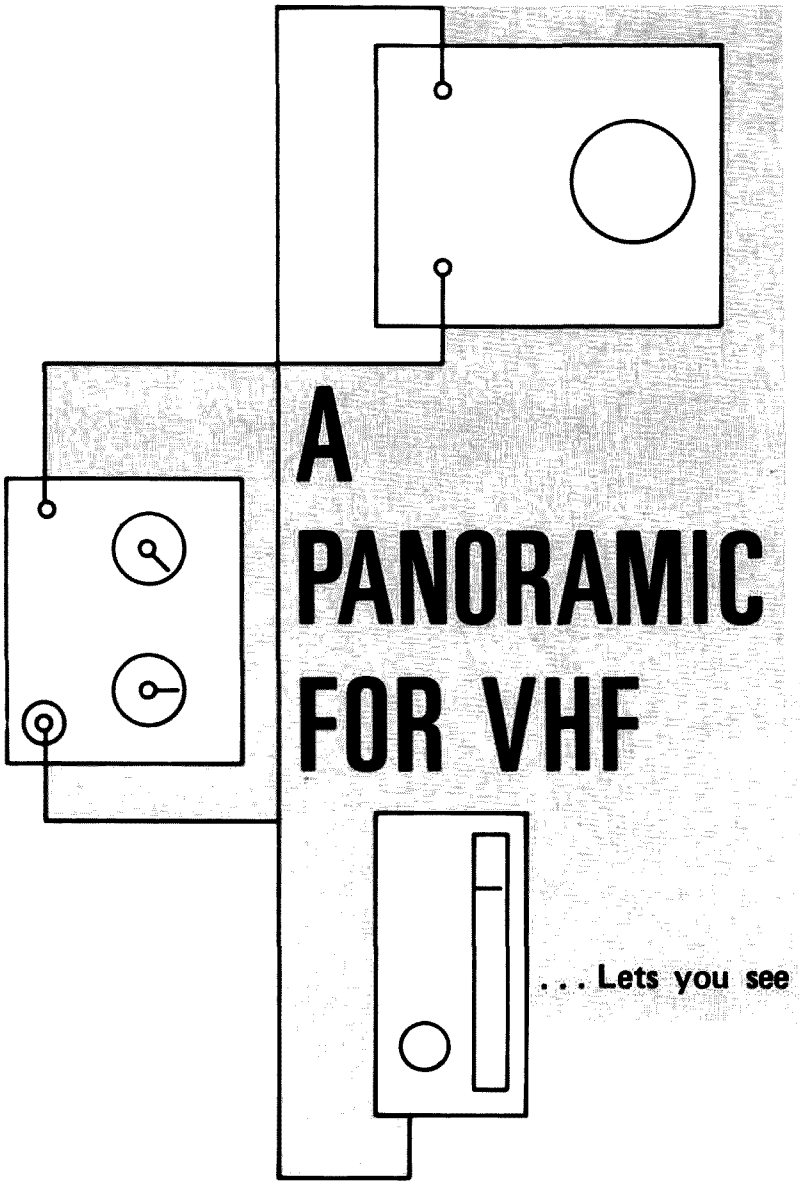


Fig. 3. Keying shaping circuit.

Though not really necessary, we added a keying shaping circuit consisting of a 100Ω, 1W resistor in series with a 4 µF, 350V capacitor. This circuit shown in **Fig. 3**, goes from the keying "hot" lead to ground.

. . . W2AOO■

Sergio Lovisolo I1SLO
Via Ravina 70,
Malnate, Varese, Italy



A PANORAMIC RECEIVER FOR VHF

. . . Lets you see the whole band at once

One of the more typical aspects of my father's (I1LOV) personality is that he wants something new in his ham shack every day, and this requires a lot of brainwork from me, to satisfy his never ending need for strange gadgets.

A few evenings ago, he was as usual having his complicated QSOs on 2 meters, tuning the band with three different receivers at the same time, when he said, "How nice if I could take a look at the complete band, and know every moment what goes on the air."

There was no possibility of mistakes! I lighted a cigarette, as usual, before I went to explore in the junkbox and began to work. A day later, there was the panoramic receiver, with his calibrated scale showing up every signal on the 2 meter band. And now the complete story.

The first approach was quite fast. I took a generator, injected a sweep signal in the socket of the crystal in the local oscillator of the converter (144-28 MHz), connected the oscilloscope to the last i-f in the receiver, and in a few minutes I had the band on the screen (Fig. 1). But the local oscillator wasn't working properly, and sensitivity wasn't very high.

If you are a lazy fellow, have a scope and a sweep generator, and a few extra converters for the various VHF bands, this is the

job for you. For me, it was nice to see that everything worked as it should, but I was sure that there was a simpler approach, one requiring no modifications in the converters, and giving the possibility of hearing and seeing with only one antenna and one converter. So, it was clear I had to work on the tunable i-f receiver. But you cannot put your hands in the station receiver, especially if it is a 75A1 or 51S1, as it was in our case; so, there are two possibilities: you have some old i-f receiver around, or you build it. Fortunately, I found an old receiver I had made some years ago, a double conversion unit with no rf stage in it.

I disconnected the tuning capacitor from the local oscillator coil and connected a varicap diode in parallel. A wire from the sawtooth generator in the scope furnished the sweeping voltage. A few more modifications to the detector and first audio stage, and the output of the receiver went to the vertical plates of the oscilloscope. After a bit of tuning, the panoramic receiver was ready to monitor the 2 meter band.

Principles of Operation

A few words to explain how it works for those who are not acquainted with oscilloscopes, sweep generators, and panadapters. In every oscilloscope the trace you see is the result of the rapid sweep of the luminous spot across the screen which is produced by a sawtooth voltage applied to the horizontal plates. Now if you apply an ac voltage to the vertical plates, the spot will be subjected to a double force, one compelling it side to side, and the other up and down. Let us assume that the frequency of the alternating voltage driving vertical plates is two times that of the horizontal ones. Then in the time it takes to go from left to right, the spot will be deviated up and down twice, and will show a two-period sample of the voltage under examination.

Now, if the vertical plates of the oscilloscope are connected to the detector of the receiver, a signal will appear on the screen every time the receiver is tuned to a station. Now, imagine tuning across the band very fast—exactly as fast as the spot on the screen runs on its way from left to right. If you tune a full megahertz while the spot makes a trip, you will see a pip on the scope every time a signal is tuned in. This is due to the fact that the signal generates an output voltage only during the short time in which its conversion frequency allows it to pass through the narrow bandpass of the receiver's second i-f. If you tune from 5 to 6 MHz, the left side of the screen will be 5.0 and the right side 6.0. Every signal will show up on the scope in a place on the screen in direct relation to its frequency. Now the problem is that you cannot manually tune your receiver up and down. This function is provided by a Variac, to which is applied the same voltage that sweeps the trace. This provides synchronization between the scope and the receiver local oscillator.

Circuit Description

The receiver circuit is quite conventional and requires only a little care in isolating the circuits working at different frequencies to prevent spurious responses that will appear as pips on the screen. The input signal is link-coupled to the grid coil of an EC88 triode mixer. (You can use a 6AM4, or

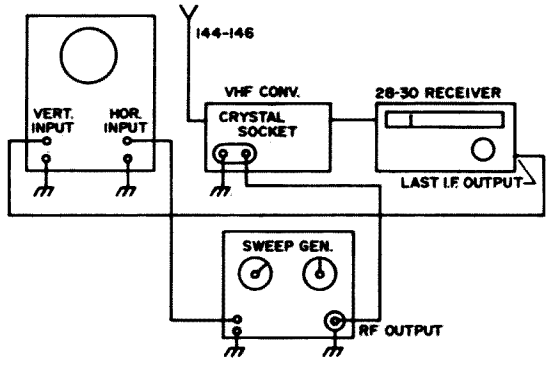
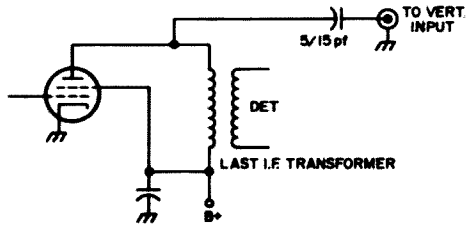
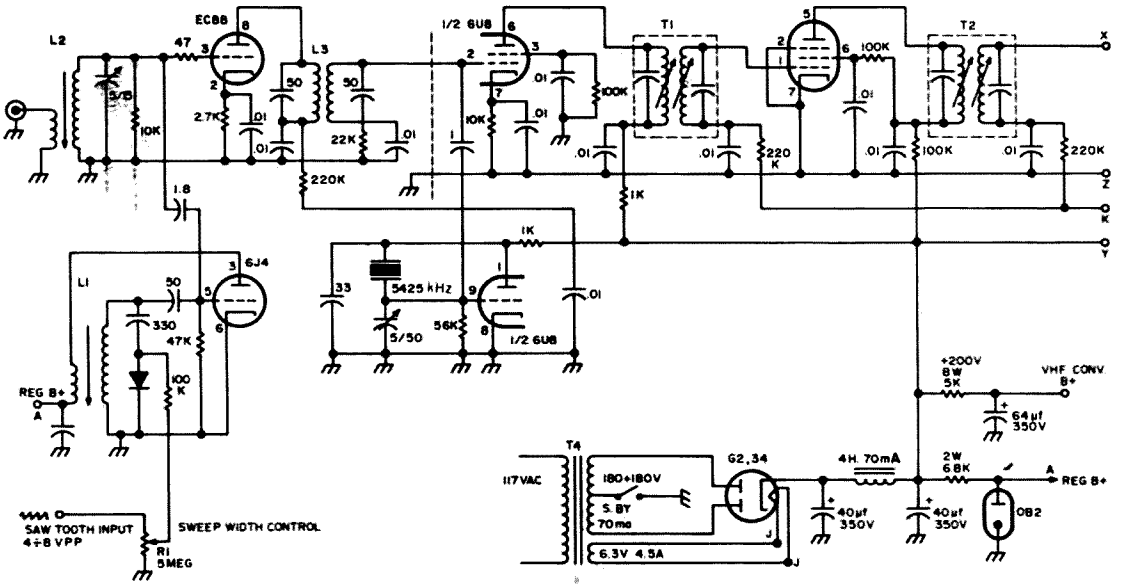


Fig. 1. Block diagram. Above, first assembly: sweep on VHF converter. Below, connect the sweep scope on vertical input to the last i-f. transformer with a 5 to 15 pF capacitor.





L1—Primary. 8 turns 26 AWG close wound 3/8 in. slug-tuned coil.
Secondary. 8 turns 26 AWG close wound.
L2—Primary. 2 turns 26 AWG on cold side of grid coil, 1/2 in. slug-tuned coil.
Secondary. 7 turns 26 AWG close wound.
L3—10.7 MHz i-f transformer.
T1, T2, T3, — 455 kHz i-f transformers.
All resistors 1/4W except otherwise noted.
D1 capacitors are mica or ceramic disc.

Fig. 2. Schematic of the panoramic receiver.

something like that; any rf triode will work.) A BA 102 (5–15 pF range), driven by a sawtooth voltage coming from the scope's sweep generator, is connected across the grid coil of a 6J4 local oscillator, sweeping its frequency from 21.120 kHz to 23.120 kHz to provide a first i-f of 6.8 kHz. A 6U8 second mixer local oscillator converts this signal to 455 kHz with a quartz crystal resonating at 5.425 kHz. I was compelled to use such unusual i-f frequencies by the crystal I had on hand. You can try other combinations, but be sure you don't use a first local oscillator frequency starting at 24 MHz; otherwise, you will have a spurious response at 144 MHz that will probably be heard by your VHF converter. The same care in selecting the second oscillator's quartz crystal must be used in order not to have spurious responses in the 28-30 MHz range. Two 6BA6 stages at 455 kHz provide plenty of gain and are very stable, showing no tendency toward oscillation. One diode section of a 6AT6 tube is the detector, the other provides a little agc, while the triode section is the video preamplifier. You can omit it and use a crystal diode if your scope has a multitube vertical amplifier. B+ voltages are provided by a GZ34 full-wave rectifier. As you can see from the photo, screening is provided between rf and first i-f stages and 455 kHz i-f section.

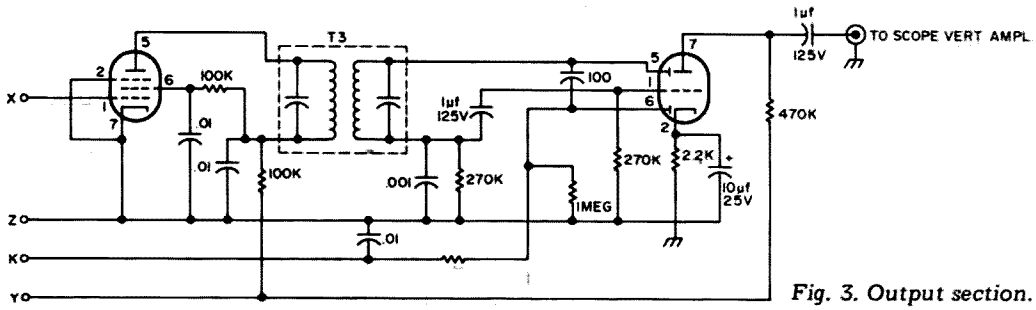
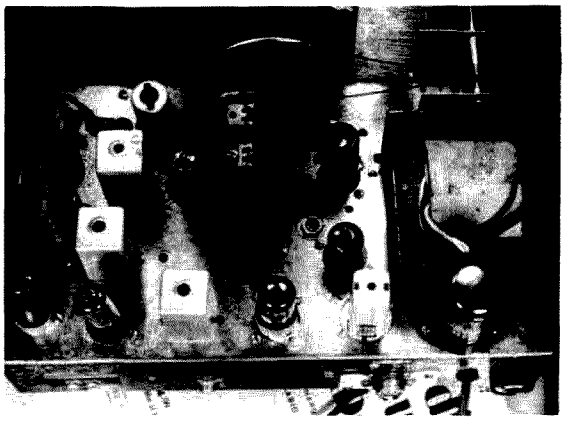


Fig. 3. Output section.

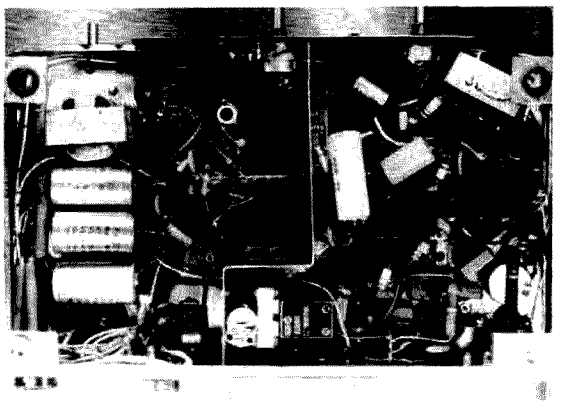


Top view of panoramic receiver.

Construction Details

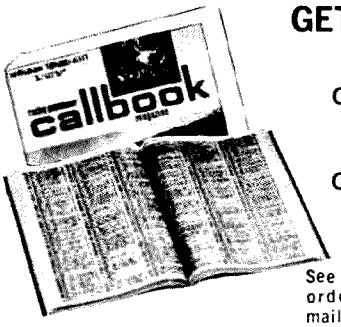
You can get an idea of the disposition of the various parts by looking at the photos. (The tuning condenser and the screened tube near the last i-f transformer are no longer in use, due to the fact that the receiver was built as a normal audio unit.) As you can see, the power transformer is a very big one. You can simplify the supply without degrading the performance of the receiver. This will allow you to use a smaller chassis.

The positions of the various components are not too critical, and you have only to be careful that you make good ground connections and use good quality bypass capacitors. As shown in the picture, I used a lot of big old mica capacitors from surplus strips. In the rf and i-f stages, connections should be as straight and short as possible. Bypass every hot filament pin. Coil L3 is a 10.7 MHz i-f transformer, and you must modify it to tune around 7 MHz. Take the coil out of its can and parallel small-value capacitors to



Bottom view of unit.

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the internal ones, if any, until you find resonance around 7 MHz (with the slugs half in) on a grid dip oscillator. After that, you can close the cans again. (Mine tuned with 50 pF.)

The crystal controlled local oscillator is very simple, with nearly nothing to tune, and starts without any difficulty. Coupling is provided by a 1 pF capacitor from pin 9 to pin 2. A few twisted turns of wire work equally well. The i-f amplifier, having a very high gain, requires a little care. Short wiring, bypass capacitors connected to the i-f transformers where the leads enter the cans, and eventual shielding connected across the tube sockets will keep everything quiet.

My receiver was built on a normal chassis (that of an old S-102 Hallicrafters 2 meter receiver), but the second time, I found that it is much easier to build converters and little receivers on printed circuit boards. They are easy to drill, offer a very good, easily soldered ground, and you can readily make a chassis of any dimensions you want, and begin to build while you wait for the box to be made.

Tuning Up

First, connect the vertical amplifier of your scope to the video output of the receiver. Then, with no B+ on the 6U8, 6J4, and EC88 tubes, connect a 455 kHz generator to the grid pin (2) of the pentode section of the 6U8 tube, and tune all the slugs in the 455 kHz i-f transformers (beginning from the last one) for maximum height of the trace. Keep the output from the generator as low as possible, consistent with a readable trace on the scope. Too much output will cause distortion, and no more trace height. Repeat two or three times. Next, connect B+ to the 6U8 tube. The local oscillator should start immediately. Connect the generator, tuned near the first i-f frequency (6.88 kHz in our case) to the grid pin of EC88 tube, and try to get an output (be careful not to tune on the image, which is about 900 kHz lower than the fundamental. Tune the slugs in L3 and trimmer capacitor from pin 9 of EC88 for maximum output. Now disconnect the 10 kΩ resistor in parallel with L1 and tune it at 29 MHz with a grid dip oscillator. Find the sawtooth generator tube in your scope. Normally, when the sync selector is in the internal position, the output from this tube is connected across the "horizontal gain" potentiometer. Be sure that there is no high voltage on this control. With a VTVM or a scope, verify that there is 5–10V of the sawtooth voltage between the hot side of the potentiometer and ground.

If everything is right, connect a shielded wire from the hot side to the "sawtooth input" in the receiver. Now, connect B3 to the EC88 and 6J4 tubes. With the generator connected at the antenna plug tuned at 29 MHz turn R1 (sweep width control) till you see a pip on the center of the screen. Rotate the sweep frequency of the scope till you get the narrowest pip. (Sweep frequency must be as low as possible, around 30–60

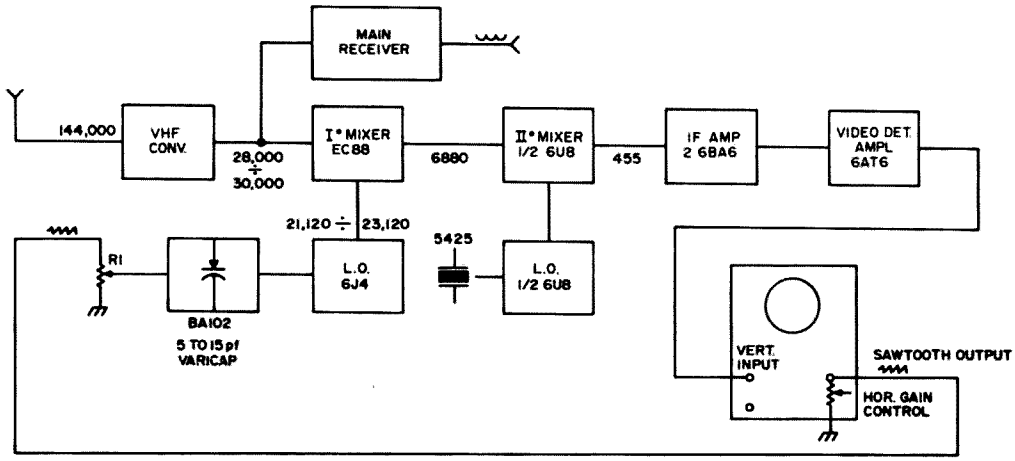


Fig. 4. Block diagram, final assembly

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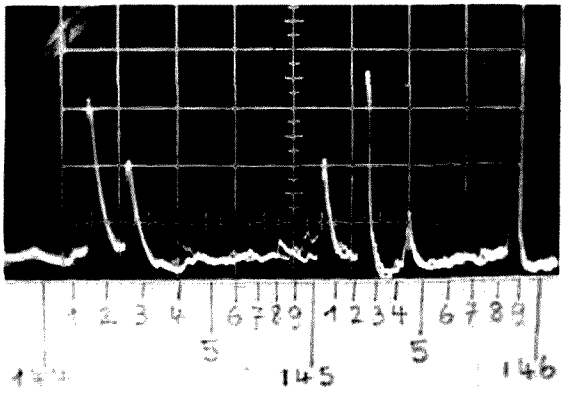
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Hz.)Tune around with the generator and notice how many MHz you are seeing on the scope. If the sweep is too wide or too narrow, rotate R1 till you get the wanted width. Now, with the generator again at 29 MHz, recenter the pip on the scope, turning the slug in L1. Repeat the preceding steps several times, till you get the wanted bandpass.

If you are not interested in the center frequency being at the center of the screen, with slight adjustments, you can put 28 MHz at the left side and 30 MHz at the right side of the screen. (Naturally, if you want, you can select other frequencies, from about 26 to 32 MHz just tuning the slugs, with up to 4–5 MHz bandwidth.) Now, tune L2 for maximum response at the center of the trace, and select a swamping resistor that gives an equal response in every point of the trace. Usually, the 10 kΩ unit marked on the diagram will do, depending on coil Q and the desired bandpass width.



Scope trace

Now you can calibrate the screen with a frequency scale. As you can see from the photo, the scale is not linear, as in any capacity-tuned oscillator. Another source of nonlinearity can be an irregular sawtooth tension. Differences often found in inexpensive varicaps make it difficult to track oscillator and antenna coils. The first time, I tried to track L2 with another varicap fed with sweep voltage (you can see two little black controls near L1), but that resulted in sweep noise coming into the station receiver, and this approach had to be abandoned. This happens when the 2 meter converter used for the panadapter and the receiver is the same.

Now you can connect the output of your VHF converter to the panoramic receiver and *see* the band. If there is too much "grass," it is better to reduce it, detuning the last i-f transformer a little instead of reducing the vertical gain on the scope.

On-the-air Performance

It is possible to see many signals just above the noise level. (In the photo you can see six). The panoramic view proves useful on many occasions—to have an idea of activity on VHF, while working other frequencies, for roundups, for turning the antenna to the best compromise position in a multisided QSO, to tune VHF converters, for zero beating, etc.

The best part: I got a reprieve, of sorts. This toy has kept my father busy enough that he's lost the kick for something new every day.

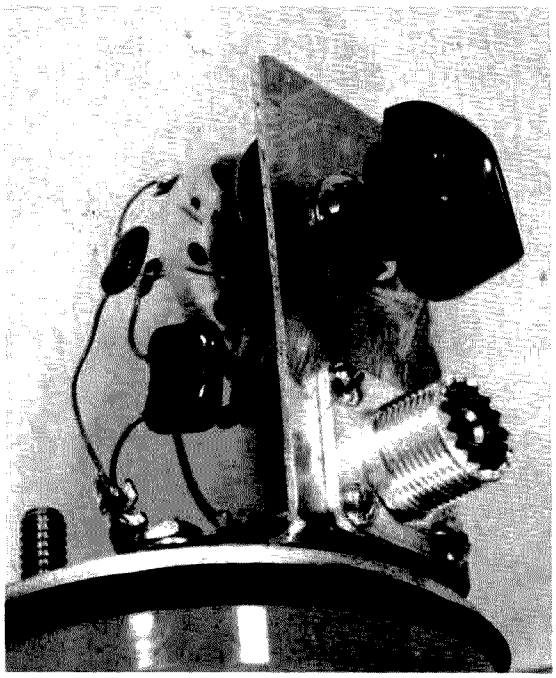
. . . I1SLO ■

Kayla Hale W1EMV
Box 224
Dublin NH 03444

VARIABLE-IMPEDANCE MOBILE MOUNT

By far the most popular mobile antenna is the center load coil variety. These come in various sizes, shapes, and colors, depending upon the whim of the manufacturer. The New-Tronics model, for instance, comes in a quiet shade of gray, and depending upon power rating and frequency, varies between about ½" and 2" in diameter. Waters Manufacturing favors black for the color and has an assortment of shapes for the coils. Webster has recently come out with a new KW series. The coils are white in color. They are sometimes referred to as the "White Bubble."

Each of these has its advantages, and efficiency varies from band to band. So it is highly possible that one might use different coils and tips for different bands. In my particular case, the Webster KW-80 has proved very successful for 75 meter operation. However, on a long trip, multiband operation using the Waters 75 meter coil with the Band-Adder (see Dec., '67, *73 Magazine*) makes it possible to operate 10-15-20 and 75 without getting out to change coils.



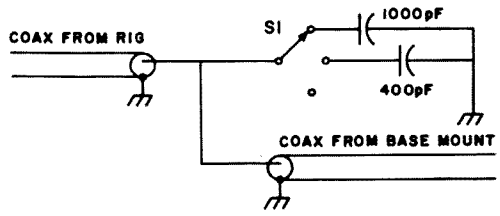


Fig. 1. Schematic diagram.

Waters and New-Tronics claim a 52 ohm match and require no further matching device. Webster suggests the use of some type of impedance matching on 80 and 40 meters. Tests have shown that a 1,000 pf silver-dipped mica capacitor from the center conductor to ground provides a good impedance match on 80, and a 400 pf capacitor provides the proper match on 40. No matching is required on 10-15 or 20 meters. Now, let's face it – connecting and disconnecting capacitors at the base of the antenna every time you want to change bands becomes Excedrin Headache No. 74.

After knocking heads with Bill McCracken, K1GUU, we came up with this nice little switching arrangement. In this case, a deck mount is used. A ceramic switch and an Amphenol SO239 connector have been mounted on a bracket attached to the backing plate. The two capacitors have been connected from the switch to ground, leaving one position a direct connection with no capacitance added. In this way it is a simple matter to hop out of the car, change the coil and tip, and merely turn the switch to the position required for the given antenna. My thanks to Bill for the actual construction.

. . . W1EMV ■

lossy transmission lines

An amateur I contacted the other day said he was using a 10 meter dipole for 20 meters and was getting an swr of 1.2:1 —which is hard to believe. He said his "swr is low and the transmitter loads up" and therefore he was perfectly happy with this arrangement. However, on 40 and 80 meters, he could not use this 10 meter dipole since the swr was greater than 8:1.

The idea of a two-band dipole intrigued me, so I pressed for more details. He was using 200 ft of RG-58/U coax and a 1 kW amplifier. The weather was cold (New England winter), he was getting out, and therefore he was not about to change this arrangement.

His transmission line was acting as a "loss pad," an impedance matching scheme which is used extensively in audio work. A loss pad can take the form of a T, H, ladder, or even a simple series resistor. Its gain is always less than unity.

Consider the simple case of a 5 kΩ plate load to be matched to a 10Ω voice coil. A perfect match results if a 4.99 kΩ resistor were put in series with the 10Ω voice coil. But look what happens to the useful power output. Approximately 1/500 of the power appears across the voice coil and the rest is lost as joule heat in the resistor.

This also reminds me of two experiments which I developed for lecture demonstrations. In one experiment I load up a pair of oldfashioned bedsprings connected back-to-back in dipole fashion, gamma matched, to perfect swr. The transmitter loads up but there is little radiation.

The other experiment uses 225 ft of RG-8/U coaxial line of mongrel origin which shows good swr but blisters badly when 1 kW is pumped into it.

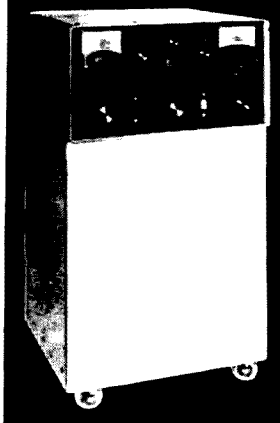
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Getting Your Extra Class License

STAFF

Part XIII: Examining Filtering and RTTY

In the beginning, ham radio had only one kind of communication available—telegraphy, using a hand key. (We can't call it CW, because in those days continuous-wave transmissions didn't exist; spark gaps generated the rf.)

As the years passed, the spark gave way to CW, and telegraphy gave way to voice communications to some degree. Voice work was all done with AM originally, but as the art progressed FM and the many varieties of sideband joined the procession.

Today, ham radio has its choice of many kinds of communication techniques. Hand-key CW, automatic-key CW, AM voice, FM voice, SSB, and DSB are the most widely used, but facsimile, television, and digital telegraphy (more commonly known as RTTY) are also very much in the picture.

Since the Extra Class license is the highest grade issued in the Amateur Radio Service, the FCC rightfully insists that aspirants to this ticket be familiar with the entire range of techniques available to hams. As a result, the examination for the Extra Class license includes questions on the lesser-used techniques as well as on the more common practices.

In this section of our study course, we'll look at some of these more specialized questions. Specifically, we'll cover the subjects of RTTY and filtering. On the official study list, these subjects are the basis of the following questions:

5. What is meant by "frequency shift keying" and how is it accomplished?

13. Draw a block diagram of an RTTY system showing the primary function of each stage. What is the proper way of identifying an RTTY transmission? What is the most widely used frequency difference between the mark and space frequencies in a conventional RTTY transmitter?

41. How do filters attenuate harmonic emissions?

49. If a crystal lattice filter has bandwidths of 3 kc/s at the 60 dB points and 1.5 kc/s at the 6 dB points, calculate the shape factor. At what frequency is the best shape factor achieved in a crystal lattice filter?

64. How do phasing condensers help stabilize crystal filter circuits?

Following our usual practice, we'll supplant these highly specific questions with a set of more general questions for our discussion. This time, we will actually have two sets, one for each of our two subjects.

The starting point for RTTY is most general—"What is RTTY?" Filling out this subject is our second question, "How is RTTY transmitted and received?"

On the subject of filters, we must be almost as general and begin by asking, "How do filters operate?" We can then ask, "How is filter performance rated?" and finally become a bit more specific when we examine "How are rf bandpass filters constructed?"

Radioteletype

What Is RTTY? The first electrical communications technique was, of course, telegraphy. Samuel F. B. Morse is generally

credited with the invention of telegraphy (although, like Marconi in the case of radio, Morse's major contribution was to gather a number of discoveries made by others into a working system and promote it to the world). The familiar hand key was, for several decades, the only means of originating any electrical communication.

As the years passed, a number of inventors attacked the problems imposed by the hand key and its requirement for an operator who knew the telegraphic code. Eventually, Joy Morton and Charles L Krum developed a machine which was able to bypass the operator requirements. It was, essentially, a cross between a typewriter and a telegraph system. In 1915, the Associated Press adopted the Morkrum machine.

Meanwhile, Edward Kleinschmidt independently came up with a machine to perform the same purpose. In 1925, the Morkrum and Kleinschmidt companies merged, and five years later AT&T bought the firm. The machine was named "Teletype" by blending the prefixes of "telegraph" and "typewriter," and the firm was named the Teletype Corporation. The word "Teletype" is, incidentally, still a registered trademark of the Teletype Corporation and cannot legally be used to refer to any other make of teleprinter equipment. Its common abbreviation, "TTY," is not a trademark and can be used as a general term.

TTY machines were designed with the requirements of land-line telegraphy in mind, but during World War II it became apparent that radio transmission could replace the land-lines with little change in techniques—and RTTY (radio TTY) was born.

Amateur RTTY got its start in 1946 when a number of hams on both coasts, in a parallel but apparently unconnected action, persuaded several companies to release obsolete machines to ham use instead of smashing them for junk.

Today, TTY equipment has many uses besides the original land-line telegraphic application, and as a result machines are not too difficult to locate. For instance, TTY equipment is widely used in the digital computer industry (where the machine is known as a "remote terminal") and as of the summer of 1969, at least a dozen firms were producing machines for this purpose which had never participated in the telegraph-communications use.

The principle upon which TTY operates is similar to that of normal CW transmission, with one major difference. Where CW makes use of five different kinds of signals—dits, dahs, and three lengths of spaces to indicate in-the-character space, word space, and sentence space—TTY uses only two. The two kinds of signals used by TTY are called "mark" and "space" and may be represented in several different ways. The advantage gained by using only two kinds of signals is that a machine can then interpret the signal with a minimum of "logic" or decision-making circuits; conventional CW with its one-unit dit, three-unit dah, and one-, three-, and five-unit spaces would require much more interpretation to decode. This is simple for humans, but most complicated for a machine to perform (although machines *have* been built to do so).

Because of the differences in the kinds of signals used, TTY equipment does not employ the International Morse Code. Instead, it uses one of several other codes which assign characters to combinations of the mark and space signals. Amateur and most commercial equipment uses the "International Five-Unit Code," but equipment designed for use with computers is more likely to employ the "American Standard Code for Interchange of Information" or a different code originally introduced by the Friden Company for its "Flexowriter" equipment.

Regardless of the code used, the signals sent and received by a TTY machine consist of groupings of "mark" and "space" signals. At the machine itself, "mark" is usually represented by the presence of current in the line, and "space" by the absence of current, so that they can be thought of as "on" and "off" conditions. This same representation *can* be used in the circuit from one machine to another, and the result is known as "make and break keying." Ordinary CW is sent by make and break keying, for instance. For the machines, however, the use of make and break keying makes it impossible to distinguish an extended "space" condition

from a circuit failure and resulting total loss of signal—and so other representations are usually employed instead.

The most common technique used to represent "mark" and "space" conditions in RTTY is to use two radio frequencies rather than just one. One frequency represents "mark" and the other is "space." Now a loss of signal can be recognized by the absence of *both* the mark and the space signals, while an extended "space" condition is signaled by the presence of the space signal.

The two frequencies are usually very close together. The difference between the mark frequency and the space frequency is known as the "shift," and the normal shift is only 850 Hz. This tends to minimize fading because the two signals will fade together. Narrow-shift is also used, with a shift of as little as 150 Hz, to minimize fading effects still more. Any shift less than 900 Hz is legal for use.

It makes no difference which of the two frequencies is used for "mark" and which for "space," but common ham practice is to use the higher of the two frequencies for "mark." In case one station chooses to reverse this, all the other station need do is to reverse the polarity in his receiver—which may be done by merely tuning to the other side of zero beat. The situation is exactly the same as the choice between upper and lower sidebands in SSB operation.

In TTY work, again regardless of the actual code used (and for the rest of our discussion we will assume that the International Five-Unit Code is the one to be used, since it is the one required for ham RTTY by FCC regulations), each character begins with a "start" signal and ends with a "stop" signal. This makes the total character length with a five-unit code actually seven units.

The "start" signal is always a "space" and the "stop" is always a "mark." These two signals establish timing synchronization between the transmitting machine and the receiving machine, and thus make it possible for the intervening code signals to be decoded.

When no character is being transmitted, a steady "mark" signal is sent. The "space" condition produced by the start portion of a character then starts the machine's decoding mechanism. The decoding mechanism sorts out the next five signal conditions to determine what character is being sent, and stops. The "stop" portion of the character simply provides enought time for the decoder to come to rest before another character can be sent.

Normal speed for amateur RTTY equipment is 60 wpm. At this speed, each part of a single character (except for the "stop") lasts for 22 milliseconds. The stop is half again longer, or 31 msec, for a total character duration of 163 msec.

A TTY machine has the appearance of a typewriter; its major parts so far as the operator is concerned are the keyboard and the printer.

When a key on the keyboard is pressed, it sets up in some type of memory device the actual code to be transmitted. This memory device may be either mechanical or electronic. The machines in general use all employ mechanical memory; pressing a key pushes down a notched lever, which then latches in the "down" position. Each key has a different lever, and the notches on each lever correspond to the "space" portions of the character for that key. All these notched levers rest on top of and across another set of five levers, so that when a notched lever is latched down it pushes down any of the second group of levers which do not have notches above them, and leaves up any of the second group which are matched by notches.

This second group of levers operates a set of five contacts, one for each unit of the character code. A motor-driven distributor then wipes a selector brush across the five contacts in turn (the "start" bit of the character is built into the selector mechanism, as is the "stop" bit at the end). If the contact lever for any one unit is up, a "space" is sent when the selector brush wipes across that contact; if the contact lever is down, a "mark" is sent. When the selector brush leaves the last contact, the distributor motor stops and the keyboard is unlatched in preparation for the next character to be sent.

Figure 1 shows the international 5-unit code, without start and stop bits. The

CHAR. LTR	CHAR. FIG	CODE BITS 1	2	f	3	4	5
A	–	x	x	o			
B	?	x		o		x	x
C	:		x	o	x	x	
D	$	x		o		x	
E	3	x		o			
F	!	x		o	x	x	
G	&		x	o		x	x
H	lbs			o	x		x
I	8		x	o	x		
J	'	x	x	o		x	
K	(	x	x	o	x	x	
L	)		x	o			x
M				o	x	x	x
N	,			o	x	x	
O	9			o		x	x
P	0		x	o	x		x
Q	1	x	x	o	x		x
R	4		x	o		x	
S	bel	x		o	x		
T	5			o			x
U	7	x	x	o	x		
V	;		x	o	x	x	x
W	2	x	x	o			x
X	/	x		o	x	x	x
Z	"	x		o			x
space				o	x		
car ret				x		x	
line fd			x	o			
fig		x	x	o		x	x
ltr		x	x	o	x	x	x

Fig. 1. International 5-Unit Teleprinter Code, required by FCC regulations for use in ham TTY. "x" entries represent "mark" pulses and blank entries represent "space" pulses. See Fig. 2 for timing of signal and start-stop frame which surrounds each character code.

column headed "code bits" shows the code as it would be represented on paper tape; bit 1 is the first one sent after the start bit, and bit 5 is the last sent. The "f" column with its all-"o" entries represents the sprocket feed hole of the punched paper tape, and is *not* a part of the code. An "x" in any entry represents a "mark" condition, and a blank represents a "space."

We have seen how the operator's pressure on any one key is translated into the code pattern to be transmitted to represent that character. The reverse operation, translation of a received code pattern into a character to be printed, is accomplished in much the same way by the printer. However, the printers of the various models of TTY machines are the areas in which the most drastic differences occur.

The explanation of printer action which follows is based on the action of the Teletype Model 12 machine, which is now obsolete. More recent machines operate in substantially different ways, but the model 12's operation serves to explain the basic idea without complicating the description with the complexities of single-magnet operation.

The received signal is applied to the printer as a make-and-break keyed current, with "mark" represented by the presence of current and "space" represented by its absence. In the absence of any received signal, "mark" condition exists and current is flowing through the printer line.

In the printer, this current flows through a latch relay and six selector magnets. So long as current flows through the latch relay, the printer is inactive.

When a character appears, its arrival is indicated by its "start" bit which is a "space" condition. This drops out the latch relay and permits the drive motor to turn the receiving distributor through one revolution.

As the receiving distributor rotates, it connects each of the six selector magnets, in turn, to the signal line at 22 msec intervals. Each selector magnet is either tripped or unaffected by the signal line; if the line condition is "mark" when the selector is connected to the line, the magnet is tripped, and if the line condition is "space" nothing happens.

The first five selector magnets control notched levers, which in the "tripped" position block movement of the key levers which do the actual printing. When all five of these notched levers have been tripped, only *one* key lever can match the notches in all of them. Every other key lever will fail to match a notch in at least one of the code levers.

The sixth selector magnet, which is tripped by the stop bit, permits the printer motor to drive the key-lever mechanism and print the one character which matches. After the printing, the entire mechanism is reset to its initial conditions and the receiving distributor stops, ready to start again which the next start bit arrives.

In later machines, only a single selector magnet is used and its mechanical action is routed to the appropriate points for each bit by a cam which sets up toggle action at the

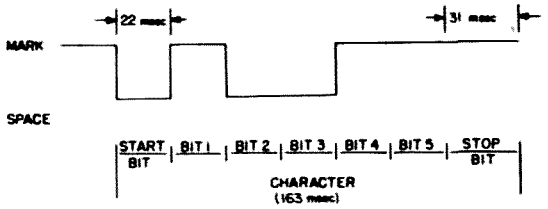


Fig. 2. This waveform shows the appearance of the character "B" as transmitted in the asynchronous serial RTTY code. While code contains only five units, character as sent includes seven. Every character has a "space" start unit, and a "mark" stop unit, in addition to the five units which carry character's meaning. All bits except stop bit are equal length, 22 msec at 60 wpm speed. Stop bit is longer, 31 msec at 60 wpm, to "pad out" to transmission rate and allow time for equipment to stop between characters.

proper time. Some machines do not use key levers; instead, they position a "type box" in front of a hammer so that the selected character will be printed when the hammer strikes.

Not all characters in a TTY machine cause printing. Some, such as "carriage return," "line feed," "letters," and "figures" cause mechanical action in the printer instead.

What we've looked at so far in this examination of RTTY principles is simply the keyboard and printer portions of the TTY machine itself, and applies equally to land-line or wireless operation.

In a land-line setup (called a "local loop" when one is set up in a ham shack, as for test purposes), the keyboard contacts are connected in series with the printer selector magnets and a power supply which frequently is 150V dc at 20 or 60 mA. Pressing a key causes generation of the code character, and the serial code character operates the selector magnets and causes the printer to print. If this all happens in the same machine the result is an electric typewriter; if the keyboard and printer are in different machines, the result is telegraphy without Morse code.

To convert the telegraphy setup to radio, all we need do is find some way to put the "mark" and "space" information on rf rather than on copper wires, and then recover it to drive the printer.

We could simply substitute the keyboard for the hand key in a CW installation, and we would have make-and-break keying. The first amateur work over long distances was done in this manner because no other form of teletype operation was permitted by the FCC. At the receiver, the audio was converted to dc current to drive the selector magnet and that was all it took.

However, make-and-break is no longer used in RTTY. Frequency shift keying (FSK) is almost universally used. The frequency shifted may be the carrier itself (FSK), or an audio frequency modulated upon the carrier (AFSK). FSK is used in the HF bands, but AFSK is used by VHF RTTY enthusiasts because of the difficulty in controlling small shifts at high frequency.

A typical RTTY station is shown in block diagram form in Fig. 3, and compared to an AM station. You can see that the major differences lie in the TTY machine itself, and the circuits connecting it to the transmitter and the receiver.

The transmitter and receiver themselves serve the same purposes as in any other radio communications system. The TTY machine's keyboard generates the proper code for the character to be sent, and the "TTY modulator" converts this code into the proper modulation for the transmitter (frequency shift or FM for FSK, and a shifting audio frequency plus audio modulator circuits for AFSK). The "converter" or "terminal unit"

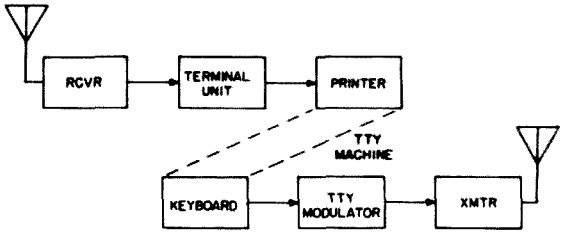


Fig. 3. Block diagram of typical RTTY station. AM station would be same except that speaker would replace terminal unit and printer at receiver output, and microphone would replace keyboard, together with AM or FM modulator or sideband generator replacing TTY modulator, at transmitter input. Major difference is presence of TTY machine, and addition of TU and TTY modulator to interface with it.

converts the receiver's output into a make-and-break-keyed current suitable for the TTY machine's printer, and the printer then converts this intermittent current flow into a character image on paper.

In the early days, amateur RTTY stations were required to identify themselves by ordinary CW at 10-minute intervals, as well as identifying in the TTY transmission. Rules have since been modified to permit all identification to be done in TTY. The general requirements for identification are the same as for all other amateur stations; both the transmitting station and the receiving station must be identified by call sign.

How is RTTY Transmitted and Received? We've already examined the means by which the operator's pressure on any one key of the keyboard is converted into an electrical code representing the chosen character, and the received electrical code is converted back into a printed representation of the character. But what goes between?

Of course, a radio transmitter and a receiver are used, but the TTY modulator and the converter or terminal unit are the items we're most interested in at this point.

There are almost as many different TTY modulator circuits and terminal unit designs as there are RTTY enthusiasts, but most of these different designs have many items in common.

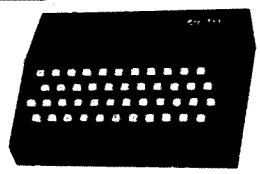
The major differences, in fact, are brought about by the choice of FSK or AFSK for the modulating technique, and by the choice between FM discrimination and simulated make-and-break for the terminal unit.

If FSK is to be used, the TTY modulator must vary the frequency of the transmitter, and the terminal unit may either generate the driving signal to the printer directly from the receiver's i-f, or indirectly from audio tones produced by the bfo.

If AFSK is to be used, the TTY modulator must first provide a frequency-shifting audio tone and then modulate the transmitter with this tone. Except for the keyed audio oscillator, normal AM transmitter techniques are usually used. The terminal unit for FSK must be of the audio variety.

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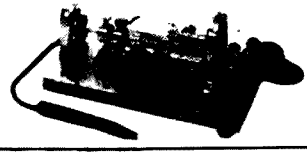
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employed for either AFSK or FSK operation, most of the popular designs have been based on this principle. For FSK-only use, however, the straight FM technique can provide the ability to dig much deeper into the crud and noise of a crowded band for solid copy of a weak signal.

Let's examine at least one of each of these types of equipment to see how it functions. Since RTTY in amateur radio began with AFSK, we'll examine an AFSK modulator and terminal unit first, followed by the FSK equipment.

One of the most popular RTTY terminal units ever described was that designed by Marvin Berstein, W2PAT, and originally published in QST. The W2PAT unit provided an introduction to RTTY for a majority of the pioneer RTTY enthusiasts—and more to our point, is an excellent example of a complete AFSK unit. It included both the oscillator to provide a keyed audio tone to a conventional AM transmitter, and the receiving converter to turn received tones into serial character codes to operate the printer.

The AFSK oscillator (Fig. 4) is almost completely conventional. The Hartley circuit provides a stable sine wave output with a minimum of components, but any other oscillator circuit could have been used (and most other circuits were, in one or another of the various designs which followed). The part which makes this circuit different from an ordinary oscillator is the diode switch and frequency-shift capacitor circuit, consisting of resistor R1, diodes D1 and D2, and capacitor C2.

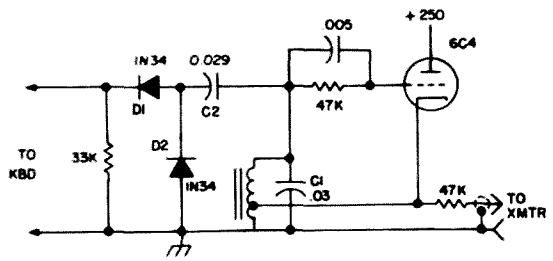


Fig. 4. AFSK oscillator from W2PAT-designed installation. Inductor is TV width coil. Output of this oscillator feeds conventional AM transmitter's mike jack. Capacitor C2's value is varied to adjust for proper shift.

AFSK operators normally indicate "mark" condition with a tone of 2125 Hz, and "space" with a tone of 2975 Hz. The oscillator is tuned, by adjustment of the coil inductance and the value of capacitor C1, to produce output at 2975 Hz when the keying circuit is open-circuited.

When the keying circuit is closed, R1 is shorted out. This permits diodes D1 and D2 to switch capacitor C2 into the circuit in parallel with C1, thus lowering the output frequency. The value of C2 is adjusted by trial and error until the output frequency is 2125 Hz.

Operation of this diode switch may appear a trifle mysterious at first, since no external power is supplied to turn the diodes either "on" or "off." What actually happens is that the diodes rob enough power from the oscillator tank circuit to develop their own switching voltages. D2 conducts for half of each cycle regardless of the keyboard contact position; during the half-cycle that D2 is "off,' D1 attempts to conduct. The current flow through D1, however, must flow through R1, and a voltage is developed at the "hot" end of R1 which tends to keep C2 isolated from ground.

When the keyboard contacts are closed, R1 is no longer in the circuit and the current flow is direct to ground on both halves of the audio cycle (through D2 on one half and D1 on the other). The diodes now act just like a closed switch, and cut C2 into the circuit.

Because of the diodes, the keyboard contacts handle only a small amount of dc rather than being required to switch ac or high-current dc. This minimizes rf interference to the receiver—in RTTY this is an important point, because the printing action on the machine normally results from the signals which have gone all the way through the system, rather than on any direct connection between keyboard and printer.

The receiving-converter portion of the W2PAT terminal unit (Fig. 5) is not so familiar-looking as the oscillator. It consists of a double-diode limiter followed by a two-stage amplifier which is operated in an over-driven condition to serve an additional limiting function. Output of the active

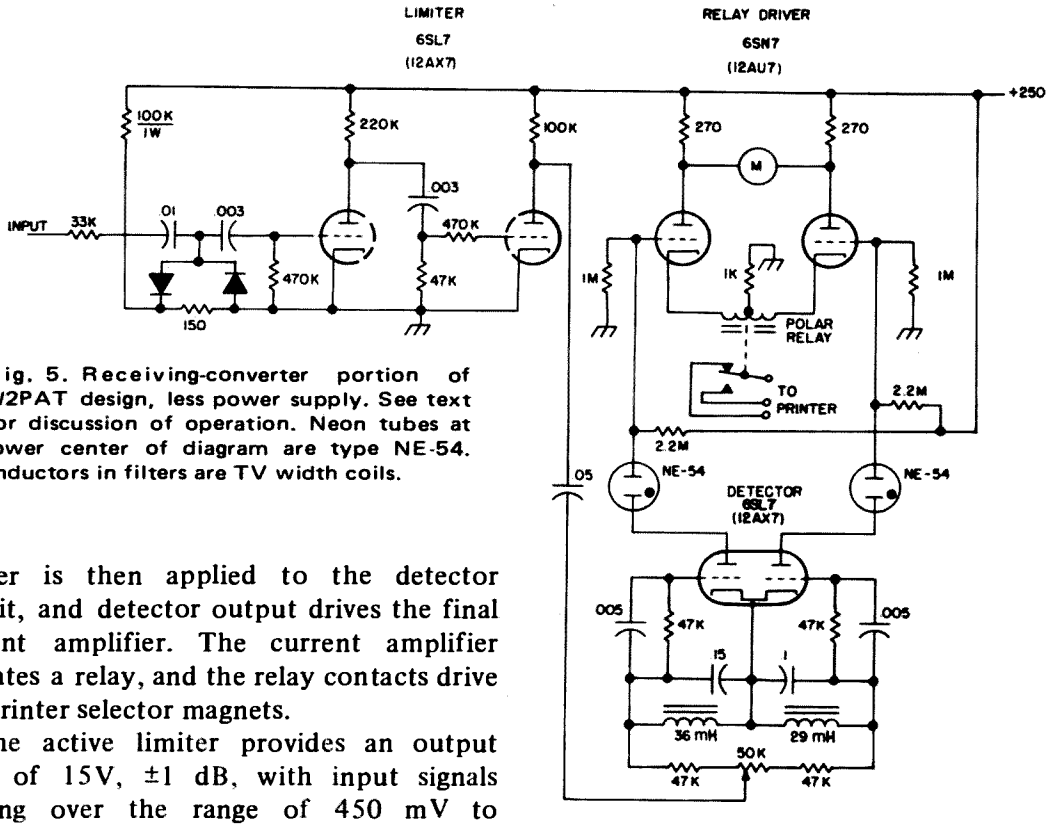


Fig. 5. Receiving-converter portion of W2PAT design, less power supply. See text for discussion of operation. Neon tubes at lower center of diagram are type NE-54. Inductors in filters are TV width coils.

limiter is then applied to the detector circuit, and detector output drives the final current amplifier. The current amplifier operates a relay, and the relay contacts drive the printer selector magnets.

The active limiter provides an output level of 15V, ±1 dB, with input signals varying over the range of 450 mV to more than 30V. This 15V signal is applied to the detector, which actually consists of two separate grid-leak detectors, each tuned to a separate audio frequency. One half of the circuit is tuned to the mark frequency and the other half to the space frequency. Since only one of these two frequencies is present at any one time, one side of the circuit is always drawing more current than is the other side, and this swing of the heavy current flow from one side to the other in the detector stage corresponds to the mark-or-space condition of the TTY signal.

The plates of the two detector circuits are coupled through neon bulbs to the grids of another dual-triode tube. The neon bulbs act as threshold devices. Until firing voltage for the neon is reached, grid voltage on the final tube remains zero. When current flow in one side of the detector drops due to lack of signal at the associated frequency, the plate voltage rises, and when the neon fires the grid of that side of the current amplifier tube goes positive. This makes that half of the final tube draw heavy current, thus pulling the polar relay to the corresponding position.

When the AFSK signal's frequency returns to that to which the detector is tuned, the detector stage current increases and plate voltage drops. When plate voltage falls below about 55V, the neon goes out and the grid of that side of the current amplifier returns to ground voltage. At the same time, plate voltage in the other half of the detector was rising and turning on the other side of the current amplifier, thus reversing current through the output relay and driving it to its other position.

The milliammeter connected between the plates of the current amplifier stage is a tuning indicator. When tuned to a TTY signal which has a mark-to-space ratio of 1:1 (as much time spent in mark condition as in space condition), the meter will indicate zero average current. This is because the meter movement is unable to follow the rapid fluctuations of current, and if the mark-to-space ratio is 1:1, the *average* current fluctuation will be zero.

Another way to provide such a test signal is simply to key an AFSK oscillator with a square wave or an electronic key set for all dits; the RYRYRY sequence is traditional

but the keyed oscillator is more reliable since it does not depend upon the keyboard being in proper adjustment.

Many other AFSK units have been described and put into use since the W2PAT unit made its appearance; a large portion of those in use today use transistors rather than tubes. The basic principles of all are similar, however, in that the two audio tones are split into separate channels and the TTY code is recovered by detection of both channels. The limiter is also a usual feature since it provides the ability to operate with a minimum of critical receiver adjustment between stations.

FSK equipment is similar in many ways to AFSK gear, but differs in some important respects. The modulator consists of a circuit to switch capacitance across the tuning circuit of the regular transmitter vfo (crystal oscillators are difficult to get enough shift on). Such a circuit is shown in **Fig. 6**. Like the AFSK oscillator, a diode switch is used, but this diode switch is powered by voltage stolen from the transmitter B+ supply. The function of the switch is to connect the added capacitor C1 across the tuning capacitor when the keyboard contacts are open, and to remove it when the contacts are closed. This makes "mark" the lower frequency and "space" the higher one. Note that this is the exact reverse of AFSK practice.

The frequency shift is usually 850 Hz, but any shift less than 900 Hz can be used legally. The variable resistor controls the amount of shift, by varying the effect of the added capacitor. When changing from one band to another, this resistor normally must be adjusted to take into account the frequency multiplication introduced by most transmitters at the higher bands.

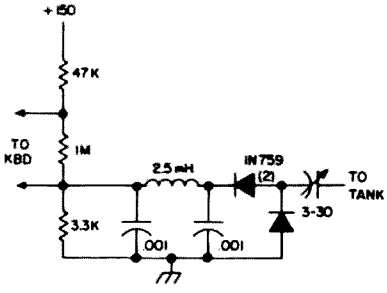


Fig. 6. Typical switching circuit for direct FSK. 3-30 pf trimmer is coarse adjustment on maximum amount of shift attainable; 1 meg pot is operating adjustment. All components to right of rf choke should be mounted as close as possible to vfo tank circuit, and be made mechanically solid to avoid frequency instability. Components to left of rf choke may be located anywhere. Keyboard contacts must be insulated from ground for use in this circuit.

Many RTTY enthusiasts receive FSK by using AFSK terminal units, converting the FSK signal to AFSK by turning on the receiver bfo and tuning carefully.

However, an FSK signal *is* an FM signal, and an FM detector operating at the receiver's intermediate frequency can in many cases give superior performance. The FM detector can be any of the conventional FM detector circuits—discriminator, ratio detector, or pulse counter. Its major point of difference from audio AM detectors is that it must respond to low-frequency signals, since the 22 msec duration of a TTY bit is about 23 Hz in sine-wave terms.

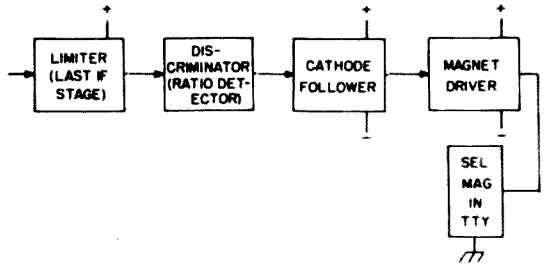


Fig. 7. Block diagram of typical direct-FSK or i-f RTTY terminal unit. Limiter and FM detector are completely conventional, but from FM detector output all the way through to TTY printer selector magnets dc coupling is employed.

Such a direct-FSK terminal unit is shown in block-diagram form in **Fig. 7**. Both the limiter and discriminator stages are completely conventional. The cathode follower between the discriminator and the driver stage permits direct coupling for good low-frequency response.

The driver stage is a switching circuit, so hooked up that a "mark" signal produces current flow through the output terminals and a "space" signal stops the flow of current. Both positive and negative power supplies are used so that the output terminals will be at approximately ground potential to minimize shock hazards.

Filtering Devices

How Do Filters Operate? The temptation is always present to answer a question phrased "How do . . . " with "Very well, thank you!" and let it go at that—but this would hardly be fair, since we asked the question ourselves in the first place. Besides, many filters operate only poorly, if at all, because until very recently filter design was essentially a cut-and-try proposition. Classical theory upon which the design was based called for physically impossible components in the filter, and substitution of realizable items led to inaccuracies in the design. This situation, fortunately, has now been cured, and we'll look at "how" a little later.

The purpose of a filter is to separate ac signals. In general, a filter must fall into one of four categories—"highpass," "lowpass," "bandpass," or "bandstop." A highpass filter passes all signals higher in frequency than its cutoff frequency and stops all lower-frequency signals. A lowpass filter does the reverse. A bandpass filter passes all signals between its lower and upper cutoff frequencies and blocks signals either higher or lower in frequency than its passband limits, and a bandstop filter blocks passage of frequencies within its band while permitting all others to pass.

These four categories of filters are based upon the action performed by the filter. Any filter, though, must operate at some specific frequency or frequencies. The frequencies involved may be subsonic, audio, intermediate, or radio frequencies. The design of any specific filter depends upon both the action to be performed, and the operating frequencies involved. Components employed in the filter, and the apparent principle of operation, may vary widely with the action and the frequency.

However, when we get right down to the basics we find that all filters operate on the same basic principles despite apparent differences. These apparent differences are best illustrated by some examples of various filters: The filter portion of a power supply is a lowpass filter operating in the subsonic frequency range, while the TVI filter on a transmitter output is usually a lowpass filter operating in the rf region. A TVI filter of the sort connected to affected TV receivers is a

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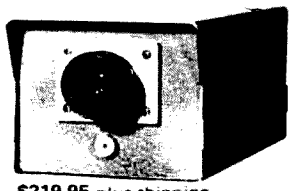


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highpass filter operating in the rf range. The mechanical filter used in SSB work is a bandpass filter operating at the intermediate frequency, and so are the crystal lattice filters also used in SSB. For that matter, an i-f transformer is a bandpass filter, as is any resonant circuit. RTTY filters are also bandpass designs, but operate in the af region.

All filters are based on the frequency-dependent properties of reactances (even the mechanical filter makes use of the mechanical equivalent of electrical reactance). Capacitive reactance X_C decreases as signal frequency f rises, while inductive reactance X_l goes up with increasing frequency. By proper choice of the type and amount of reactance any desired filter action can be obtained (within reasonable limits, as we shall see a little later).

To illustrate the principle, let's examine a single stage, subsonic, lowpass filter typical of those used in many power-supply designs. The schematic appears in Fig. 8.

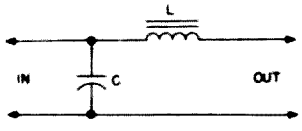


Fig. 8. Single section lowpass filter. Values of L and C determine cutoff frequency of filter section.

At frequencies far below the "cutoff" frequency of this stage, the inductor presents a very low value of X_l and the capacitor has a very high value of X_C. Both reactances are so extreme that they may be ignored, and the filter becomes in effect a straight piece of wire with no effect on the signal.

At frequencies far above cutoff, the situation reverses. The inductor's reactance is very great and the capacitor's reactance is very low. The filter becomes in effect a dead short, with no path from input to output, and the signal is blocked.

The "cutoff" frequency of this type of filter is defined as being that frequency at which X_l equals X_C. At this frequency, since reactance is equal in both directions, half the signal current flows to ground and the other half flows through the filter. The signal is neither passed without loss nor blocked completely.

At frequencies near cutoff, the situation is similar to that at the cutoff frequency. Signals slightly below cutoff frequency will be slightly attenuated, but the lower the frequency becomes the more of the signal goes through and the less of the signal is bypassed to ground. Signals slightly above cutoff are still partially passed, but as the frequency rises less and less of the signal makes it through the filter. There is no such thing as a perfect filter which passes everything below cutoff and blocks all above.

Filter performance can be improved, though, by adding more stages. If two of these stages are cascaded one after the other, then at cutoff frequency the first stage will block half the signal and permit half to pass. The second stage will block half of the half that passes through the first, and permit only 1/4 of the original signal to get through the composite filter.

Adding a third such stage will reduce the output signal level to 1/8 that at the input. A fourth stage will halve this, to 1/16 the original level. Five stages will cut the output to 1/32, and so forth.

When extra stages are added, though, the definition of "cutoff frequency" must be changed. Each stage's cutoff frequency is defined exactly as before, but the cutoff frequency of the filter as a composite unit becomes lower with each added stage, because for any filter the definition of "cutoff frequency" most generally used is that frequency at which the filter reduces output signal level to half the level present at the input.

Our two-stage filter in the example would have a composite cutoff frequency only 0.7071 times as great as the single-stage filter; the three-stage filters cutoff would be at a frequency half that of the single stage filter. These ratios apply only to the simple design shown in Fig. 8; more complex filter designs have different rates of cutoff-frequency change, and in general a filter is designed for specified performance rather than being built up of some arbitrary number of identical stages.

We have just examined the basic principles as applied to a simple lowpass filter. A highpass filter works the same, except that the inductor and capacitor are inter-

changed so that signals *above* cutoff are passed and those below cutoff are blocked rather than vice versa as in the lowpass circuit.

To get a bandpass filter, we could simply build a highpass filter with cutoff set at the lower band limit, and follow it by a lowpass filter with cutoff set at the upper band limit. For extremely wide passbands this is sometimes done. One example is the 300-3000 Hz band frequently used for voice communication; this is too wide a bandpass for simple bandpass filters to handle, and the economical way out of the problem is to first trim off one limit and then trim the other.

For narrow passbands, though, something more like a tuned circuit is generally used.

Not all filter stages are as simple as that shown in Fig. 8. Tuned circuits may be included instead of simple reactances, and the resonance frequencies may be far different from the intended cutoff frequency in order to modify filter performance. The variations possible in filter design on this basis gave rise to the "image-parameter" theory of filter design, which ruled the design of most filters for more than 30 years and even today is still widely used.

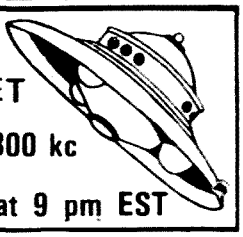
However, reactances which satisfy the demands of image-parameter theory are physically impossible, because the theory demands that the resistive portion of the circuit be zero at cutoff frequency, changing in the same manner as a capacitive reactance below cutoff, and changing in the same manner as an inductive reactance above cutoff, while actual resistances are independent of frequency.

Because many filter requirements are only approximate, this design method has been able to give circuits acceptable for most purposes. When more accurate designs were required, cut-and-try fitting of values was the normal course.

Any filter, though, is a network of components connected together, and any such electrical network must obey certain basic rules known to engineers as "Kirchoff's Laws." These state, in essence, that as much current must flow into any point as flows out and vice versa. We might say simply that the current must go somewhere—it can't just disappear!

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These rules can be written as a series of algebraic equations, and to apply them to the analysis of any arbitrary network we must do just that. The laws state that all the current must be accounted for, and the equations do the accounting.

Since a filter is a network, the filter can be described by a suitable series of equations. The filter designer can then solve the equations to find the network parameters which will produce optimum performance in some desired respect. Performance will be poorer than optimum in some other respects when this is done, since all design represents compromises, but the "modern network theory" design technique for filters permits the designer to choose the performance he wants where the "image parameter" approach permitted only one or two parameters to be designed for.

We won't go any deeper than this into modern network theory, since it *is* a mathematical technique and one of our guiding principles in this course is to stay away from all mathematics which we can avoid. If you're interested, the fourth edition of "Reference Data for Radio Engineers" (and presumably the just-published fifth edition as well) contains 47 pages (pages 189 through 235) describing the technique.

We'll merely note that the modern-network-theory design approach permits a number of different filter response curves, and the resulting different filters are usually identified by names associated with the shapes of these curves. The two most widely known are the Chebishev (also spelled Tshebysheff, Chevishef, and Tshebishev) and the Butterworth filters. The Chebishev design provides the sharpest possible rate of cutoff at the cost of permitting ripple in the passband, while the Butterworth design maintains passband response flat at the cost of moderate phase shift and less steep cutoff rates.

It may seem a bit odd for us to declare that all filters are based upon reactance when crystal lattice filters composed of several quartz crystals are so widely used, but electrically the crystal is just a very-high-Q tuned circuit and contains both X_l and X_c. When used in a filter, the X_l and X_c provide the filtering action. We'll look at this in more detail in a subsequent section. First, let's see how filter performance is rated.

How Is Filter Performance Rated? Filter performance is rated according to several factors, and the factors involved vary to some degree with the type of filter in question. One factor present in the rating of every filter is its "attenuation"; this is a measure of the signal level at the output side of the filter compared to the level at the input side.

Every filter possesses some definite value of attenuation at every frequency. A low-pass filter has attenuation both below and above its cutoff frequency, as do highpass filters, bandpass, and bandstop varieties. Attenuation is usually expressed in dB.

If the output level at some specified frequency is the same as the input level, the attenuation at that frequency is $\emptyset$ dB. If the output level is zero for any value of input level (a condition theoretically possible but not attainable in practice because of stray coupling around the filter), the attenuation at that frequency is infinite.

A plot of attenuation versus frequency gives the "response curve" of the filter. Fig. 9 shows typical response curves for the four categories of filters.

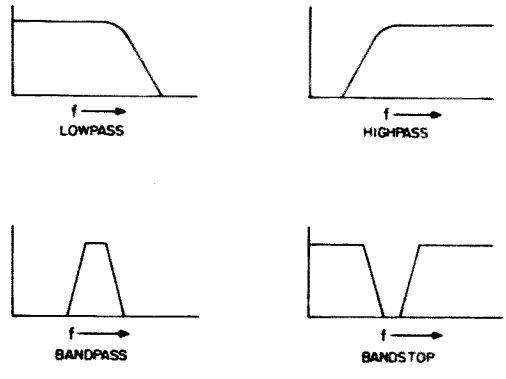


Fig. 9. Typical response curves of the four major categories of filters. These response curves are idealized; actual response curves have more rounded corners and never quite reach the zero-output point.

Another factor in common for all filters is "cutoff frequency," but now that we have established the meaning of "attenuation" we are in position to define cutoff frequency

more accurately than we did earlier. The cutoff frequency for a given attenuation may be specified as the frequency at which the filter has that value of attenuation. Thus the 3 dB cutoff frequency for a lowpass filter will be lower than the 6 dB cutoff frequency. The definition we developed earlier—that frequency at which output level is half of input level—actually defines the 6 dB cutoff frequency of any filter.

A glance at Fig. 9 will show that both bandpass and bandstop filters have not one but two cutoff frequencies, since for any specified value of attenuation there is a frequency below the filter's center frequency which has that attenuation, and another frequency above center frequency. The two cutoff frequencies of band filters are designated as "upper" and "lower" cutoff frequencies.

Sometimes filters are compared according to their "slope" or "cutoff rate." This is a relative term referring to the rate at which attenuation changes with frequency. Engineers speak of slope or cutoff rate in units of "dB per octave"; this means the number of dB change in attenuation when the frequency is doubled. A single reactance has a slope of 6 dB per octave; that is, if frequency is doubled the reactance is either doubled or halved, and the resulting ratio is 6 dB (2:1 voltage or current, and 4:1 power ratio). Filters with two reactances usually have slopes of 12 dB per octave, with the slope increasing 6 dB per octave for each added reactance in the filter. This is not an airtight law, however; many filters have slopes which do not follow this rule, and almost no filter follows this rule at frequencies near the cutoff point or within the passband.

All filters have a "bandwidth," but the term has different meanings depending on whether the filter is (1) lowpass or highpass, or (2) bandpass or bandstop. For lowpass or highpass filters, the bandwidth for a specified attenuation is the actual frequency at which the filter has that attenuation. The "width" means the number of cycles from zero frequency to the frequency in question. Thus the bandwidth for 3 dB attenuation of a lowpass filter with a 3 dB cutoff frequency of 100 Hz is 100 Hz.

For symmetrical bandpass or bandstop filters, the bandwidth is the difference (in hertz) between the two cutoff points for the specified attenuation. A bandpass filter with an upper 3 dB cutoff frequency of 10 kHz and a lower 3 dB cutoff frequency of 8 kHz would have a 3 dB bandwidth of 10-8 or 2 kHz.

Bandwidth is always specified for a definite attenuation level, because it is defined in terms of cutoff frequencies, which are themselves defined only by attenuation level. Unless the attenuation level is specified, any use of "bandwidth" as a rating factor is meaningless.

For bandpass filters in particular, the bandwidth is one of the primary measurements—but it is by no means the only one. Consider two different bandpass filters, both having 6 dB bandwidths of 3000 Hz. The first, however, is a very simple filter with only a few reactances and consequently has a very slow rate of cutoff, while the other is a complex Chebishev design with steepest possible cutoff rate. The first filter may have a 60 dB bandwidth of 30 kHz and the 60 dB bandwidth of the second might be as narrow as 6 kHz. (**Fig. 10**).

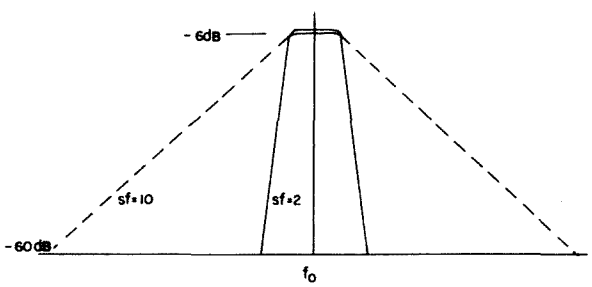


Fig. 10. Significance of "shape factor" is shown here. Both filters whose response curves are illustrated have 6 dB bandwidths of 3 kHz. That in solid lines has a 60 dB bandwidth of only 6 kHz, while that in dotted lines has 60 dB bandwidth of 30 kHz. Difference in effective passband is clearly evident.

Obviously, the second of these filters will do a far better job of trimming applied signals down to its passband.

The term "shape factor" is used to describe the property we have just compared; the "shape" referred to is that of the

filter's response curve. A perfect bandpass filter would have absolutely vertical sides to its response curve, with zero attenuation between the two cutoff frequencies and infinite attenuation outside that range. Actual bandpass filters have response curves which vary from a barely perceptible hump up to a steep-sided curve very much like that of the perfect filter.

The "shape factor" of a bandpass filter is the ratio between its bandwidths at two different attenuation levels. In ham practice, the 6 dB and 60 dB bandwidths are the ones most often used. The shape factor ratio is always obtained by dividing the larger bandwidth by the smaller, so that it is always greater than 1. A perfect filter with vertical sides to the response curve would have the same bandwidth at all attenuation levels, and so would have a shape factor of 1. Practical filters always have greater bandwidth at high attenuation levels than they do at the lower-attenuation points, and so their shape factors are always greater than 1. If the 6 dB bandwidth of a filter is 1.5 kHz and the 60 dB bandwidth is 3.0 kHz, the 6-60 dB shape factor of that filter is 3.0/1.5 or 2; this represents excellent performance. Many bandpass filters in use today have shape factors as great as 10. The shape factor of a single tuned circuit when used as a bandpass filter may be as great as 100.

How Are RF Bandpass Filters Constructed? One of the requirements for any receiver intended to operate in today's crowded rf spectrum is that it have extreme selectivity. Ideally, it should be able to tune in either sideband of an AM signal while rejecting both the carrier and the other sideband. This is known as selectable sideband capability, and marks an extremely selective receiver.

Almost universally, such selectivity is achieved by use of bandpass filters operating in the rf or i-f range. Since normal i-f's are actually radio frequencies, we'll lump these filters together for our discussion.

RF bandpass filters capable of providing shape factors smaller than about 10 are most often one of two major types—mechanical filters and crystal filters. We won't go into details of the mechanical filters here, since they have little to do with electrical and electronic phenomena.

Crystal filters themselves divide into two major groups. One of them uses only a single crystal, to provide a very narrow response curve with relatively poor shape factor. This type, which was standard equipment on older communications receivers, provides excellent results on CW but is not so hot for reception of voice signals. The second group, which used two or more crystals, provides greater bandwidth than the first, with smaller shape factor. It is widely used in SSB operation, since the shape of its response curve matches the requirements for voice communication.

The single-crystal type of filter is normally known simply as a "crystal filter," while those using two or more crystals are generally called "crystal lattice filters." Technically, a lattice filter must use four crystals, or multiples of four, but an electrically equivalent circuit called a "half-lattice" requires only two crystals, and is possibly the most popular type of lattice filter in use now.

Let's examine both groups of filters separately, taking the older single-crystal filter first. The schematic of a typical single-crystal filter circuit appears in Fig. 11. The driving transformer splits the signal into a pair of signals, equal in strength but opposite in phase. One of these two signals is applied to the quartz crystal while the other is applied to a "phasing condenser" which is simply a variable capacitor. The two signals are then put back together at the input to an amplifier stage.

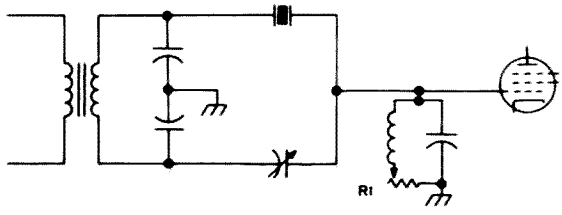


Fig. 11. Typical single-crystal i-f filter of type used for CW reception. Adjustment of capacitor tunes out parallel resonance of crystal to give symmetrical passband, or can move parallel resonance to either side of series resonance to insert a "rejection notch" anywhere within passband except at series-resonant frequency itself.

The quartz crystal is equivalent to a very high Q resonant circuit; it has both series and parallel resonances. At the frequency of series resonance, it is an extremely low resistance, while at the frequency of parallel resonance it is an extremely high resistance. In the absence of the phasing condenser, this circuit would permit signals at series resonance to pass through almost unchanged, while attenuating signals at other frequencies greatly and providing almost infinite attenuation at parallel resonance.

The phasing condenser, however, provides an alternate path for the signal around the crystal. When the phasing condenser is adjusted so that its capacitance exactly balances the parallel capacitance of the crystal and its holder, the parallel resonance of the crystal is eliminated and the filter's response curve becomes a single sharp peak. The rejection notch at parallel resonance is eliminated.

When the phasing condenser is adjusted for either more or less capacitance than that required to balance the crystal, the effect is to tune the parallel resonance of the crystal to some definite frequency. This introduces the rejection notch, and makes it possible to move the rejection notch relative to the passband peak, permitting a single interfering frequency to be "notched out" of the signal.

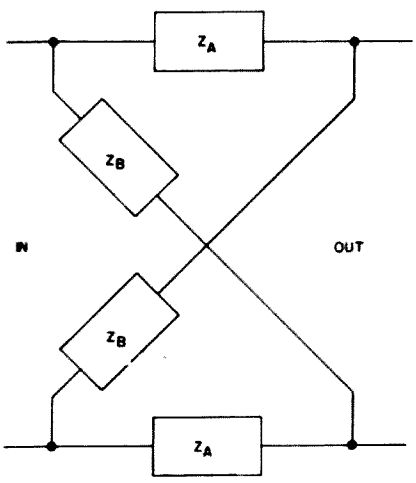


Fig. 12. Full-lattice filter arrangement in block diagram form. Each block represents an impedance having characteristics of the circuit shown in Fig. 13. When interconnected as shown here, passbands of "A" and "B" sections interact to provide a flat-topped passband with excellent shape factor.

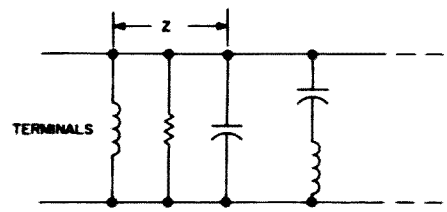


Fig. 13. Equivalent circuit of each impedance in full lattice filter. Parallel-resonant circuit at left represents parallel resonance composed of crystal and stray circuit capacitance, together with loading resistances. Series-resonant circuit at right (which may be extended indefinitely as indicated by dotted lines) represents series resonances of each crystal in each leg. Impedances "A" and "B" are parallel resonant at lower cutoff frequency. Series resonances introduce "infinite rejection" notches just outside passband to sharpen skirts of filter.

Adjustment of resistance R1 modifies the loading imposed on the filter, and varies the effective bandwidth. The 6 dB bandwidth of such a filter circuit can be varied from about 50 Hz when R1 is extremely large, out to greater than 6 kHz when R1 is very small.

The multiple-crystal filter designs are based on the lattice structure shown in Fig. 12. Each section of this lattice structure consists of one or more crystals, and provides the equivalent of the circuit shown in Fig. 13. Much of this circuitry can be eliminated by replacing the lattice with its equivalent shown in Fig. 14; the lattice arms themselves now require only single quartz crystals using their series resonances.

Characteristics of such a filter are determined primarily by the number of crystals used, and the degree to which they are matched. Those crystals marked A and those marked B must not tune to the same frequency. In fact, the spacing between the series resonant frequency of crystals A and that of crystals B is the major factor determining the filter's bandwidth.

Design of such a filter is done by modern network theory, usually using the Chebishev techniques, and is too complex for us to explore here. In general, the bandwidth determines the spacing between resonant

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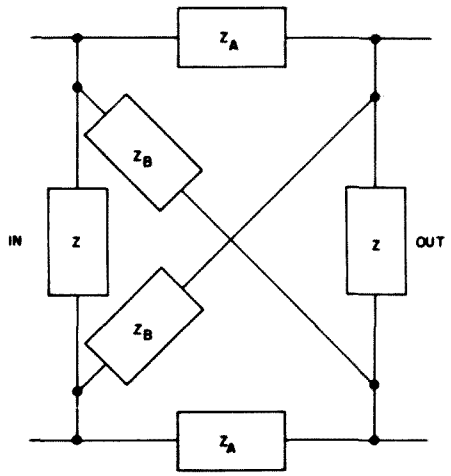


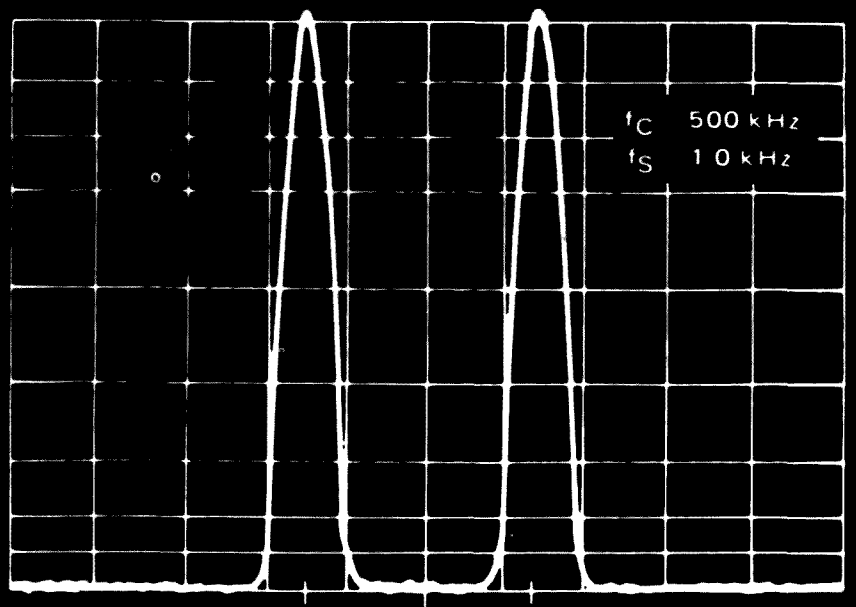
Fig. 14. Load resistances and stray circuit capacitance of full lattice filter can be moved to input and output terminals as indicated here. This circuit is electrically the same as that of Fig. 12. Each "A" and "B" block is still the circuit of Fig. 13, which may in practice consist of a single crystal for each block.

frequencies of the two groups of crystals. Within each group, characteristics of each crystal must match as closely as possible (many commercial crystal filters use a single crystal with multiple electrodes on it, each pair of such electrodes serving as a "different" crystal in the lattice, to assure identical characteristics). So long as the filter's center frequency is not greater than about 250 times its desired bandwidth, good shape factor can be attained easily. That is, for a "phone" bandwidth of 3 kHz, any center frequency up to 750 kHz could be employed. In fact, successful lattice filters with center frequencies as high as 10 MHz and bandwidths as small as 2 kHz have been built, but design is more critical.

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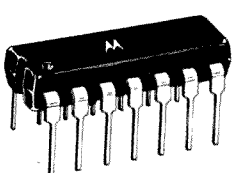
NEW LINEAR ICs FOR THE HAM

. . . . . THEY'RE NEW, HOT, AND CHEAP !

Hams have been using integrated circuits almost since they were first introduced commercially at reasonable prices. The earliest ham uses were keyers and frequency standards using digital ICs. ICs are so useful in these applications that it is difficult to imagine anyone building a keyer out of discrete semiconductors, or (perish the thought) vacuum tubes, anymore. ICs with their low-voltage operation and great circuit simplification make even complex projects relatively easy and inexpensive to build.

The resistor-transistor logic (RTL) family (the Motorola MC700P series and the Fairchild μL900 series) has been the most popular type of integrated circuits for experimenters. Both are packaged in inexpensive plastic cases, and though the Motorola devices have won out in most uses because they are lower in cost and furnish more functions per package, many of the Fairchild parts have also been used.

There has been relatively little use by hams of linear integrated circuits up to now, though a few of the audio power amplifiers that have been introduced by RCA, Motorola, and GE in the past few years have seen some use. This would be surprising at first glance because most ham applications are linear or analog ones, rather than digital. However, the digital circuits were much cheaper and more widely available, hence attracted more attention in the past. Recently, however, many different types of linear integrated circuits have become very attractive for ham use. They are now available at reasonable prices for many applications.


605

Many of the new linear integrated circuits that are of particular interest to hams have been designed for consumer use. This assures that they will have reasonable prices; expensive ICs can find little use in consumer equipment. Table I lists many of the linear integrated circuits that are now available. They include voltage regulators, audio amplifiers of various types, i-f amplifiers, a unique new circuit called the balanced modulator, and operational amplifiers. Any one of these ICs can replace many discrete devices, and in many cases can provide much higher performance than any practical combination of discrete devices could. They also are relatively inexpensive, ranging in price from $1.50 for an i-f amplifier to $7.15 for the balanced modulator/demodulator, a recently

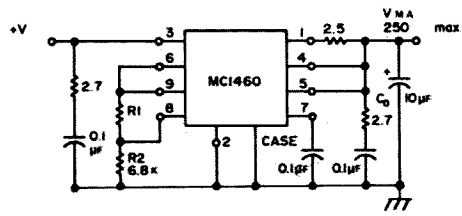


Fig. 1. High-performance IC regulator using the MC1460. The input voltage, V_{IN} must be at least 3V greater than the output. Maximum input for the MC1460 is 20V. The MC1460 is good for 35V input. An etched circuit board is recommended for construction. Use VHF techniques.

introduced part. All of the parts described are manufactured by Motorola, and are readily available from the many Motorola distributors, including Allied Radio and Newark.

Voltage Regulators

One of the most dramatic examples of the simplification that a linear integrated circuit can provide in a circuit is the voltage regulator.

The MC1460 series of voltage regulators can provide up to 600 mA of output current at over 30V with no external transistors or other semiconductors. Only a few small resistors and capacitors are required to produce a complete regulator with excellent characteristics.

Four members of the MC1460 family are of particular interest to hams. The MC1460 has a maximum input of 20V and the MC1461, a maximum input of 35V. The "G" versions (in a package very much like the TO-66 case used for silicon power transistors except that it has 9 pins instead of 2) can handle 600 mA when it's mounted on an adequate heatsink. Four similar regulators are available in the MC1560 series with a full temperature range which makes them more suitable for military use. They cost significantly more.

The MC1460 series has a typical low output impedance of only 0.025-0.035Ω at frequencies up to 100 kHz. Regulation for changes in input voltage is typically only 0.003% per volt, a remarkably low figure. The MC1460 can put out voltages as low as 2.5V and as high as 17V. The output voltage must always be at least 3V less than the input voltage for the regulator to work properly. Another interesting feature of the MC1460 series is its short-circuit protection. The regulator will not be damaged by a continuous short circuit.

A basic MC1460 circuit is shown in **Fig. 1**. It can put out a maximum of 250 mA. It uses only a few small 0.25W resistors and capacitors. In the circuit, resistor R1 is selected to give the desired output voltage. A potentiometer can be used for a variable output, but this circuit is really more suitable for a fixed rather than a variable voltage.

The regulator as shown will limit output current to 250 mA. If you try to draw more current than this, the regulator will automatically reduce the output voltage. This short-circuit current is determined by the 2.5Ω resistor connected to pin 1. This resistor can be changed to get other maximum output currents.

The MC1460G, which is in the TO-5 package, will require a heatsink for currents near its maximum, and the MC1460 will likewise require a heatsink for high current values. Probably the most practical type of heatsink for the R package is one with a hole large enough for all 9 pins to pass through without shorting. This is much more practical than trying to drill holes for each one of the nine pins. A socket is available for the MC1460R, but it is hard to find and relatively expensive.

One word of caution if you are used to building dc power supplies: The transistors used in the MC1460 are very high-quality VHF devices; hence, the circuit must be treated properly or it's likely to oscillate at very high frequencies. You'll notice in **Fig. 1** that a number of capacitors and resistors are included for high-frequency suppression to prevent the circuit from oscillating. You should use an etched circuit board for

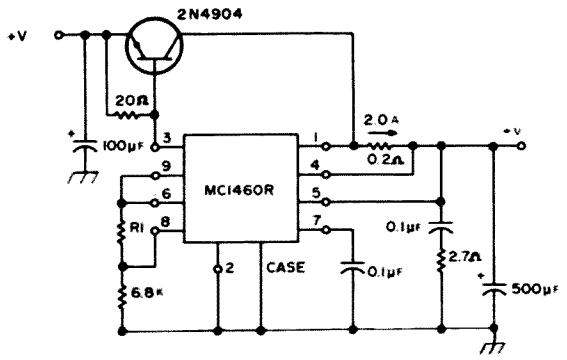


Fig. 2. IC voltage regulator with 2A capability using external series-pass power transistor.

constructing this regulator so that you can get very short leads and a good ground.* It is not practical to go into all the fine points of the circuit; however, the data sheet for the MC1460 series is comprehensive and provides complete information on using the device.

Two other circuits using members of the regulator family are shown in Figs. 2 and 3. Figure 2 is a 2A voltage regulator using an external PNP series-pass power transistor. A similar technique can be used to provide up to 10A for applications requiring this amount of current. More information is given in the data sheet.

Figure 3 is a laboratory power supply with an output adjustable from 0 to 25V. It will provide up to 400 mA. This circuit, unlike many power supplies, can go all the way down to zero volts. It is also interesting because of the extreme simplicity of the circuit. It would be interesting to compare Fig. 3 with a typical regulated power supply using discrete devices. The discrete version would be far more complex and expensive, and yet would not provide the same performance.

The Motorola MC1469 is a regulator similar to the 1460, but even less expensive, and designed for less exacting uses. No circuits are included for this device because they were not available at the time this article was prepared. However, the data sheet on the devices will give considerable information.

Another voltage regulator of particular interest is the MC1466, which is designed for use with external transistors. It can be used to regulate voltages as high as 1000V or even higher. In this application, the regulator is floating, but it can be protected against shorts even though the external pass transistor used with it may not be able to stand this high voltage if the output is shorted. More practically, or perhaps of more interest, the 1466 can be used to provide very high current at lower voltages, or provide medium current with voltages in the 100 to

*A board is available for $1.50 from Project Supply Company, PO Box 555, Tempe AZ 85281.

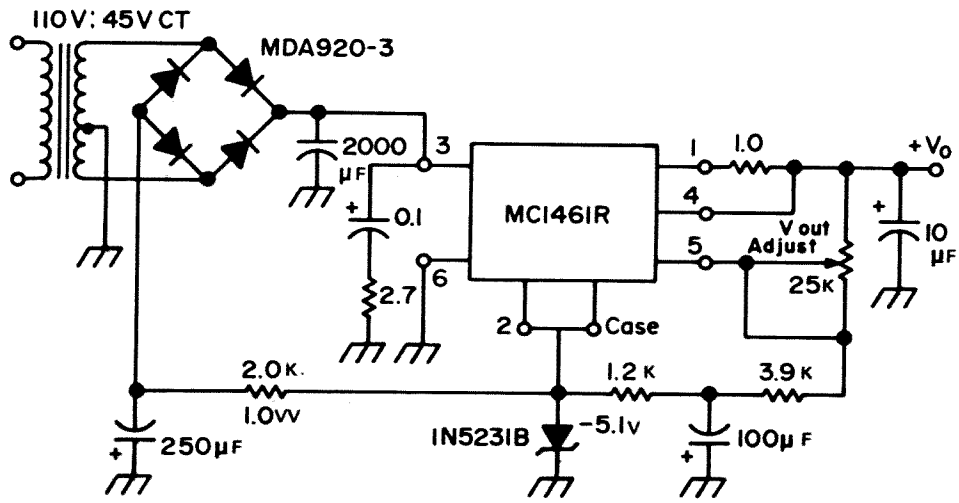


Fig. 3. 0-25V, 400 mA laboratory power supply.

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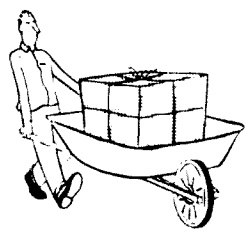
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200V range. This would be useful, for example, as a screen supply for a transmitting tube. Other voltage regulator ICs are available; most are made for use with external transistors for currents of more than about 10 mA.

All in all, the new IC voltage regulators make it very easy to design and build a power supply to provide almost any current or voltage with very little work, and assurance that the circuit will work properly without needing any adjustments. The day of the discrete semiconductor regulator seems to be rapidly approaching its end.

Audio Amplifiers

Many of the new inexpensive linear ICs are audio amplifiers. Some are designed for low-level use, others for moderately high power; that is, a watt or more. Starting at the low end of the price and complexity scale is the MFC4010, a wideband amplifier that can provide up to 60 dB of gain at 1 MHz, so it's suitable not only for audio, but also i-f applications.

The MFC4010 is one of the first of a new breed of consumer ICs. It has only four pins; the package is a small version of the dual in-line package that has become so popular. The four pins are positive voltage, ground, and the input and the output. That's all; no complex compensation is needed as has been required in the past for most ICs.

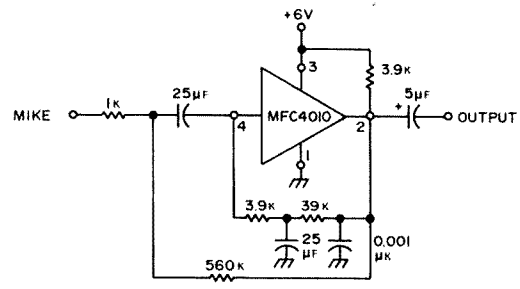


Fig. 4. High-gain audio amplifier using MFC4010 wideband amplifier.

The MFC4010 is especially useful as a microphone amplifier or as a general-purpose 455 kHz i-f amplifier. A typical circuit using this device is shown in Fig. 4. It operates from 6V; it's an audio amplifier for a microphone, and as you can see, very few external components are required to provide high gain. The MFC4010 itself contains three transistors and five resistors.

Another low-level audio amplifier is the MC1303P in the popular dual in-line 14-pin package. This dual audio amplifier was designed to be used as a preamplifier in stereo phonographs and similar equipment. It provides 60 dB of gain and is useful where high gain and two separate amplifiers are needed.

The MFC4000 is a 0.25W audio power amplifier with 15 mV sensitivity. It contains six transistors, three diodes, and five resistors. The MFC4000 uses the same small package as the MFC4010 and also has only four terminals: input, output, supply voltage, and ground. Its 250 mW of audio output may not seem like much, but it is quite satisfactory for many applications, such as pocket radios, and home equipment, where the noise level is not very high. When used with an efficient speaker, that quarter watt will drive you out of the room.

The MFC4000 draws very low standby current, typically only 3.5 mA at 9V. Perhaps the best feature of the MFC4000 is compactness. A whole audio output stage takes up very little space.

The MC1306P is also a 250 mW audio amplifier, but it includes a preamplifier, giving it a sensitivity of 3 mV for full output—considerably higher gain than the MC4000. It's packaged in a new eight-pin plastic package that looks like a shortened dual in-line package. Four transistors in the preamplifier section and ten transistors in the output section are contained in the small package. The two parts are independent and can be used in cascade with other circuitry, such as a volume control or filter between them. Like the MFC4000, the MC1306P is designed for 9V operation and has a similar low zero-signal current drain (4 mA). Typical harmonic distortion is only 1%.

A typical application of the MC1306P is shown in **Fig. 5**. This is a high-gain 250 mW audio amplifier for use in a portable receiver. Its total gain is 1000, or 30 dB. Only a few external components are required, but as with all these ICs, the component leads should be short to prevent high-frequency oscillation.

The next IC has been available for some time in an expensive hi-rel (military term for "high reliability") version. The recent introduction of a low-cost, relaxed-spec version makes it much more interesting. This device is the MC1454G. It is similar to the older MC1554G, but as mentioned, has relaxed specifications and a much lower price, $3.30 instead of $14.25.

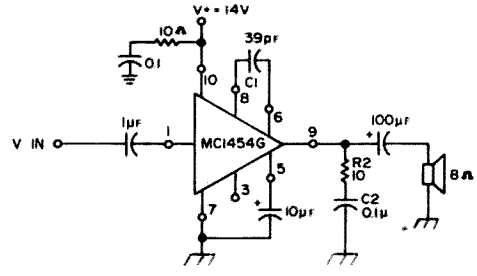


Fig. 6. Audio power amplifier has 1W gain of 10; input impedance of 10 kΩ. An external heatsink is required. The HEP593 can also be used in this circuit with similar results.

Figure 6 shows a 1W audio power amplifier. You'll notice that it uses no transformers, and operates directly from 12.5 to 14V. The gain of this circuit is 10, and the input impedance is 10 kΩ. An external heatsink must be used with this device for maximum power output.

The HEP 593, readily available at almost all electronic stores in the country, is similar to the MC1454G. Either of these devices makes an excellent output amplifier for use in mobile or home equipment. Its IW of audio power is adequate for most ham uses,

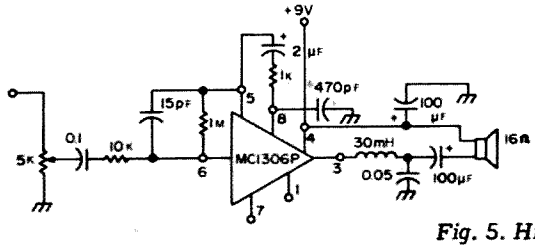
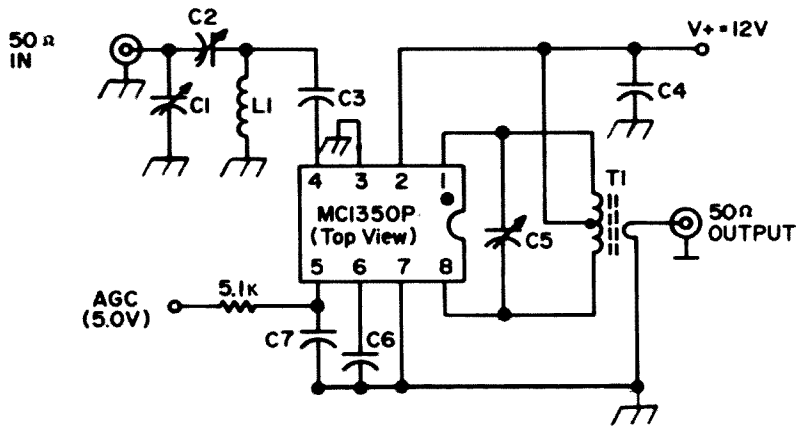


Fig. 5. High-gain (30 dB) 250 mW audio amplifier for use in portable receiver.



Component	Frequency		
	455 kHz	10.7 MHz	45 MHz
C1	–	80–450 pF	9.0–35 pF
C2	–	5.0–80* pF	2.0–8.0 pF
C3	0.05 μF	0.001 μF	0.001 μF
C4	0.05 μF	0.05 μF	0.001 μF
C5	0.001 μF	36 pF	1.0–5.0 pF
C6	0.05 μF	0.05 μF	0.001 μF
C7	0.05 μF	0.05 μF	0.001 μF
L1		4.6 μH*	0.8 μH
T1	Note 1	Note 2	Note 3

*Circuit positions of L1 and C2 are interchanged.

Note 1. Primary: 120 μH (center-tapped)
Q_U = 140 at 455 kHz
Primary: Secondary turns ratio ≈ 13

Note 2. Primary: 6.0 μH
Primary winding = 24 turns #36 AWG (close-wound on 1/4" dia. form)
Core = Arnold Type TH or equiv.
Secondary winding = 1-1/2 turns #36 AWG, 1/4" dia. (wound over center-tap)

Note 3. Primary winding = 18 turns #22 AWG (center-tapped)
Secondary winding = 1 turn #22 AWG (over-wound at center of primary)

Fig. 7. High-gain i-f amplifier with wide-range agc action. Circuit values are shown for 455 kHz, 10.7 MHz, and 45 MHz.

except modulating large AM transmitters, which hardly anyone does any more. Motorola Application Note AN-401, "The MC1554: A One-Watt Monolithic Integrated-Circuit Power Amplifier," gives more information on applications of this useful circuit. As mentioned, the MC1454 is a relaxed version of the MC1554, and the circuits described apply in almost cases.

I-F Amplifiers

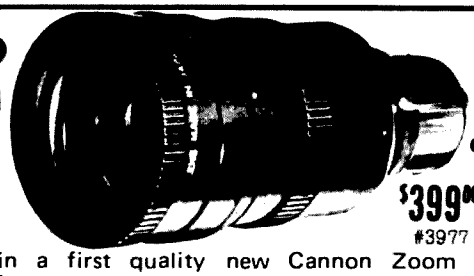
A number of new i-f amplifiers have been introduced recently; many are of great interest to the ham. In addition, one that's been around for a few years takes on a new interest in view of its recent reduction in price from $4.25 to $1.50.

The MC1350P is perhaps of greatest interest. It features very high gain at frequencies up to 60 MHz and also includes provision for very wide-range agc. Power gain is typically 50 dB at 45 MHz, and agc range is 60 dB minimum. It has very low feedback capacitance, thus does not need neutralization in spite of its very high gain. The device is designed for operation on 12V from a single power supply, unlike many of the earlier ICs. The MC1350P was designed for use in television receivers; however, it's equally valuable for many other uses, such as i-f amplifiers at any frequency up to 60 MHz. Typical gain at 45 MHz is 50 dB; at 10.7 MHz, it's 58 dB, and at 455 kHz, 62 dB. Noise figure at 60 MHz is a respectable 9 dB, but you probably would want to use a low-noise preamp if you were using this i-f amplifier in a microwave receiver. For other applications, this noise figure is more than adequate. Typical circuits for the MC1350P are shown in Fig. 7. Component values are given for frequencies of 455 kHz, 10.7 MHz, and 45 MHz.

Very similar to the MC1350P is the MC1590G, a higher-performance version sealed in a metal can for use in military equipment. The MC1590G costs $5.60 in single quantity, so you can see that the MC1350P at $3.75 would be of much more interest in most ham applications.

Either the MC1350P or the MC1590G also makes an excellent video or audio amplifier for any application requiring very wide range agc, such as speech compression circuits.

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A very simple receiver providing quite good performance could be made using a few of these integrated circuits. Discrete dual-gate MOSFETs are better in the front end: an MFE3007 is an excellent rf amplifier. An MFE3008 mixer with a separate oscillator could feed an MC1350P i-f amplifier, then a detector and MC1306P audio output amplifier.

An older, but very good, linear IC is the MC1550G rf/i-f amplifier. This is a much simpler circuit than the MC1350P, but it also offers very wide agc range, high power gain (typically 30 dB at 60 MHz), good noise figure, and extremely low feedback capacitance. The MC1550G used to cost $4.25; now it's down to only $1.50, which makes it very attractive for many applications.

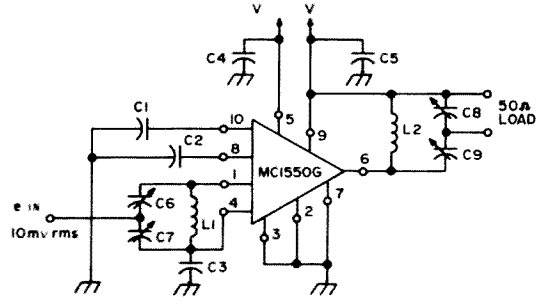


Fig. 8. MHz amplifier with 25 dB gain and good agc characteristics. The HEP 590 can also be used in this circuit with similar results.

Many circuits have been described using the MC1550G, increasing its appeal to the ham builder. A typical example is shown in Fig. 8. This is a 60 MHz amplifier with 25 dB gain; it can furnish excellent agc. Motorola Application Note AN-247 "An Inte-

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grated Circuit RF/IF Amplifier," provides more information on using the MC1550G.

The HEP590 is similar to the MC1550G. Both are packaged in the TO-5 metal can.

One of the most interesting of new linear integrated circuits is the MC1351P. This wideband FM amplifier provides i-f amplification, limiting, detection, and audio amplification. This circuit is almost a complete FM receiver, fitting in well with the recent amateur repeater trend. The MC1351P typically has 65 dB gain. It uses an interesting FM detector that requires only one external coil and capacitor in its resonant circuit.

The MC1351P was designed for use in the 4.5 MHz sound channel of television receivers (5.5 MHz for Europeans); however, it's very adaptable for use in FM receivers, either commercial FM broadcast receivers at 10.7 MHz, or in mobile communications receivers. A typical circuit using the MC1350P is shown in **Fig. 9**. This is a complete FM i-f system. It is most adaptable for use in the home, since it requires 140V dc for the audio power amplifier. However, a similar type of circuit can be used at 12V with a different audio amplifier. Motorola Application Note AN-468, "A Monolithic Circuit for Television Sound Systems," describes the use of the MC1351P in TV reception. The ham can easily convert this for FM reception in communications work.

Balanced Modulator

An interesting new linear IC is the MC1596G balanced modulator/demodulator. This circuit is a complete SSB product detector or a balanced modulator for generating DSB with no coils or external tuned circuits. It requires only a few resistors and

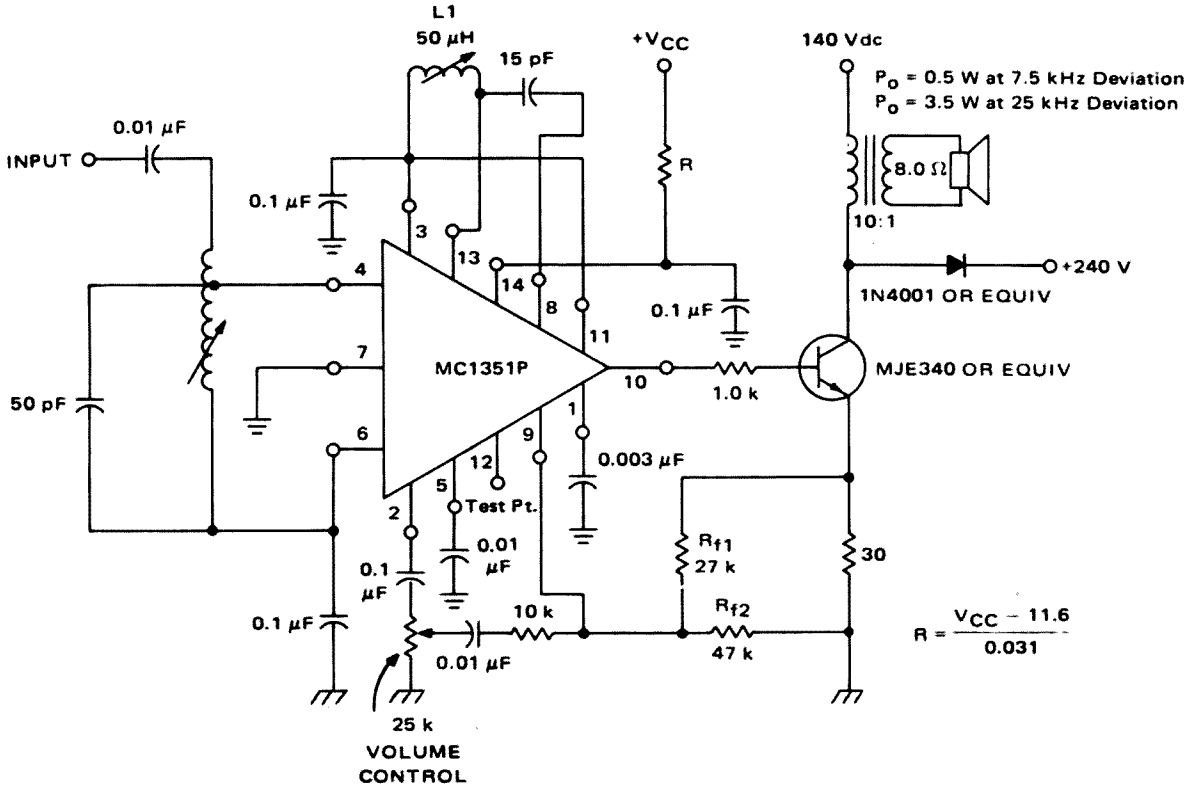
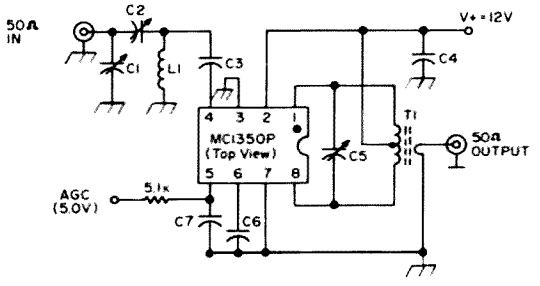


Fig. 9. Complete FM i-f system. Though this circuit was designed for use in TV receivers, it is also excellent for ham FM reception. For portable use, another type of output stage would be preferable.

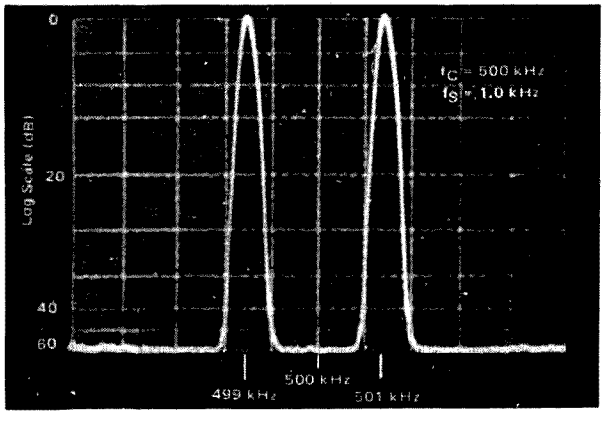
capacitors. **Figure 10A** is a typical balanced modulator circuit using the MC1596G. **Figure 10B** also shows the typical double-sideband-output spectrum that it produces. The 500 kHz carrier is completely eliminated, at least to the definition of the spectrum analyzer used, about 60 dB down. The MC1596G can easily provide 40 dB of carrier suppression at 9 MHz, perhaps the most popular frequency for generating SSB signals these days.



A

Fig. 10 (A). Balanced modulator using MC1596G and (B) double-sideband output spectrum. Carrier rejection is greater than 60 dB without using any coils.

B



At $1.75, the MC1596G is not inexpensive; however, its versatility and the simplification and high performance it brings to a circuit should make it very popular and we will likely see many applications of this type of device in the future.

Incidentally, to those of you who follow the engineering magazines, the MC1596G is a simplified cousin of the MC1595 multiplier that has been attracting a great deal of attention. The monolithic multiplier seems to be the new analog building block, similar to the op amp in its versatility, and can be

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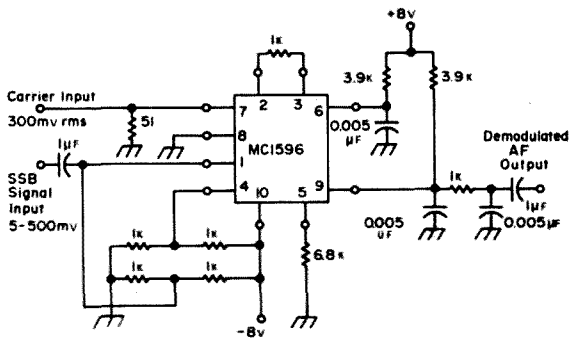


Fig. 11. Product detector using MC1596G balanced modulator/demodulator.

used in many different applications. The MC1596G is considerably simpler and less expensive; however, it still provides excellent performance in many applications.

Operational Amplifiers

Many circuits have been described using operational amplifiers, or op amps. Op amps have been around for many years, and cost as much as $200 at one time. Now you can buy a very high-quality, high-gain operational amplifier, the MC1439L, for only $2.70 in single quantities. This op amp is a relaxed version of the MC1539, which is widely used in military and commercial equipment. This circuit, though inexpensive, is extremely versatile, and can be used in almost any circuit requiring an op amp.

Conclusion

This article has provided a quick look at some of the new linear ICs of particular interest to hams. It has provided only very sketchy information, however. For more information on any device in which you are interested, you can write to the Technical Information Center, Motorola Semiconductor Products, Inc., PO Box 20924, Phoenix, AZ 85036. The data sheets on the devices provide a great deal of information, and where mentioned, application notes are also available.

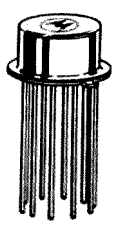
I hope this description of these circuits helps to convince you that linear ICs are now at the stage where hams can use them in their equipment. They are more economical circuits using discrete devices in many cases, and are much easier to work with.

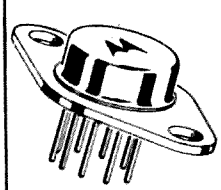
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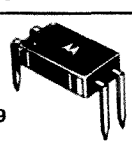
Table I. Linear ICs of Particular Interest to Hams

TYPE NUMBER	DESCRIPTION	CASE	PRICE (1-99)
Voltage Regulators			
MC1460G	20V, 250 mA	602A	$ 5.25
MC1460R	20V, 600 mA	614	6.75
MC1461G	Voltage Regulators 35V, 250 mA	602A	6.79
MC1461R	35V, 600 mA	614	8.25
MC1469R	35V, 600 mA	614	6.75
Audio Amplifiers			
MFC4010	Wideband amplifier, 60 dB gain, to 1 MHz	629	1.85
MC1303P	Dual audio preamplifier, 40 dB gain	605	5.25
MFC4000	250 mW audio power amplifier, 15 mV sensitivity	629	2.10
MC1306P	250 mW audio power amplifier, 3 mV sensitivity	626	2.90
MC1454G*	1W audio power amplifier	602B	3.30
IF Amplifiers			
MC1350P	Agc i-f amplifier (to 60 MHz), 58 dB gain at 10.7 MHz	626	3.75
MC1550G**	Agc i-f amplifier (to 100 MHz), 25 dB gain at 60 MHz	602B	1.50
MC1351P	I-f amplifier, FM detector, audio preamplifier 65 dB gain at 4.5 MHz	605	4.10
Balanced Modulator			
MC1596G	Balanced modulator/demodulator, 40 dB carrier suppression at 10 MHz	602A	7.15
Operational Amplifier			
MC1439L	High-gain, high-performance op amp	605C	2.70

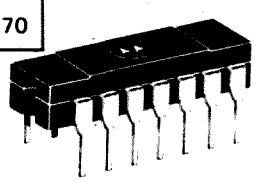
*The HEP593 is similar
**The HEP590 is similar


602


614


629


626


632

Neil Johnson W2OLU
74 Pine Tree Lane
Tappan NY

THE GLOP WILL GET YOU- IF YOU DON'T WATCH OUT

This is an old story but it's worth telling again. Twinlead can deteriorate in its performance at radio frequencies, especially when it's wet. This is old hat to most hams that have been around a while, but we tend to forget. This forgotten point was re-emphasized to me a few nights ago. I tried to fire up the rig on my favorite band, but the antenna just wouldn't take any power. All received signals sounded normal, so my suspicion was directed to the twinlead; about 75 feet of it feeds the antenna.

There had been a small rain shower, and the twinlead was covered with a thin layer of moisture, something resembling dew. Since it was late, I resolved to do something about it the first thing in the morning. Next day, the flat-top was lowered and the twinlead was scanned. Sure enough, there was a thin coating of dirt, dust and a dark sooty-looking compound. This was carefully removed with a soft piece of paper towel, which had been dampened with water. It is surprising how this stuff will pile up on your antenna insulators and transmission line. This is the same stuff that attaches itself to your car, only you are more aware of it since you must see through the windshield in order to drive. It's also piling up on your antenna system at the same time, the big difference being that you can't drive your antenna to the carwash every time it accumulates a fresh layer of dirt. But it's piling up nevertheless.

This is not something peculiar to the amateur fraternity. Couple of years ago, there was a big blackout in a Canadian province. It turned out that carbonaceous compounds had attached themselves to the high tension insulators—those big six foot insulators—and the next time it got damp, the circuits arced over. Everyone gave up on TV for that night, and went back to candles for light!

Once the black glop is wiped clear of your twinlead, it is fairly simple to wipe a little "magic compound" over the twinlead and your troubles will be gone for quite a while. The magic stuff in this case is the Dow Corning type 4 compound, a silicone base surface-coating compound, sometimes called "DC-4." This stuff will make your twinlead shrug off water like a duck's back. It is available at Allied Radio and at other well-stocked suppliers. The cost is $2.00 for a two ounce tube. At first blush, this may seem rather high. But you don't smear it on, you wipe it on with your fingers. And remember only a thin, thin layer is needed. Anything thicker than one molecule deep is unnecessary. I have a tube on hand that's been around for years. Sure it's an old story, but worth telling once more.

By the way, you can use the same compound for waterproofing the ignition wires and other components in your car which handle high voltage. The family car will be less prone to fail when you drive through a deep puddle, and the XYL will think you're an electronic genius.

. . . W2OLU ■

(continued from page 12)

Mismanagement, Incompetence, or Both?

Dear Mr. Green:

Your November editorial and Dave Mann's article regarding the ARRL were a pleasure to read. My experience as a ham has been limited as I have held a General license for less than six months. I have no basis to judge your statements regarding ARRL's lack of leadership and initiative in the technical areas surrounding amateur radio. However, as an attorney, I feel competent to comment on the other matters raised.

If what you have reported is true, I must conclude that the leadership of ARRL is grossly incompetent, dedicated to the demise of amateur radio, or mismanaged in order to suit the self-interest of a select few. A viable, dynamic company or organization, if it is seeking its greatest productive effort, cannot afford to hold $618,000.00 in cash securities. I would immediately question those in charge as to where the funds are kept, at what interest and on what basis does ARRL decide which banks will be favored with their deposits?

As you may know, any cash reserves over $100,000.00 are usually suspect by Internal Revenue as accumulated surplus. Good reason must be shown as to why the amount is carried instead of distributed to shareholders. A penalty in the form of 27½% can result if a reasonable basis fails to exist. Does a reasonable basis exist for ARRL to carry funds in excess of $100,000.00 without distributing the rest in benefits to its members? I think not. Why isn't this money being used in the many areas of amateur radio that are in dire need of increased activity? My experience in commercial affairs leads me to conclude that someone's self-interest is being held in higher regard than that of the majority. I believe that from reading your comments under ARRL National Convention Report, ARRL Articles of Association Waived, etc., that you have reached the same conclusion.

The success of your magazine is an indication that the masses of dedicated amateurs agree. They can see what is happening to their dollars and privileges. How could ARRL ever give its blessing to incentive licensing and still maintain the interests of the majority of amateurs?

I have compiled a list of some objectives which I believe would be in the best interests of the great majority of hams. Unfortunately, I also believe that ARRL would not lend support to them. They are:

1. Devising of a plan of incentive licensing which would return the frequencies lost, and further grant new frequencies for those who have advanced past General.
2. Establishment of effective representation in Washington. Greater privileges for the amateur can only come through the FCC and Congress; without their help we are powerless. How creative effort has never been utilized in this area previously is beyond belief. The possibilities are endless. It is not hard to foresee the day when amateurs could be compensated directly by the Government in return for the maintenance of an emergency communications network. Government surplus equipment could be offered directly to the amateur at reduced costs. These ideas may be "way out" to some, but think a moment about the great advantages now being extended to other special interest groups.
3. Improved public relations.
4. Recruiting drives.

I cannot imagine how an educated populace like the amateur radio community could remain silent for so long a period of ARRL inactivity. The ARRL leadership structure is, in my opinion, guilty of gross mismanagement.

Like yourself, Mr. Green, I believe that a change in ARRL thought and direction would mean greater growth for amateur radio.

I believe the time has come for an all-out drive to elect a complete slate of new directors who share our thoughts and opinions. Your magazine is one of the few vehicles available for such an objective. I strongly urge you to consider such a campaign. If I can be of any assistance, please do not hesitate to contact me.

Sheldon A. Harris **WB9BCZ**
Attorney at Law
Chicago IL **60603**

What Price ARRL?

Dear 73,

I have been reading your magazine for a few years now and I have yet to become tired of its content. I was disgusted with the others within a year. They always have the same articles in them. I always look forward to 73 arriving at my shack.

I have been reading with interest your feature "Leaky Lines." One paragraph of it is worth a whole issue of QST. The boys at ARRL have been in amateur radio so long they have forgotten what it's like to be a relatively new ham like me of only seven years. In my opinion, it's the ARRL that is stagnating, not the general ham population. They beat down any idea for improvement which is the least bit contrary to their way of thinking.

I read the minutes to the May board meeting in QST after reading them in 73 and QST's version is funnier. How these people can waste so much time and money doing absolutely nothing is unbelievable. I feel sorry for those who join ARRL expecting betterment of amateur radio and then seeing it spent on those worthless board meetings. You tell me to support ARRL because it's the only national organization we have. By joining I would support this clown circus in Newington. No sir! I won't give them any more of my money.

They sit and argue about putting info on repeaters in the handbook, when there should be no argument at all. Then QST has the guts to ask for articles on the subject, which they don't pay for, and yet they have a PAID technical staff at ARRL. What are they doing? Dusting off the spark rigs in the museum?

Any outfit can print handbooks, logsheets, and DX maps. And W1AW ought to be in the center of the country, not sitting out on the east coast. They even had to start up a code practice station on the west coast because nobody could hear that one squeaking out east. As for FCC petitions, anyone can get one up so who needs ARRL?

Jerome Grokowsky **WA9HCZ**

Pulsars, Quasars, and the Like

Dear Sir,

As Mr. Hoisington's article was, to me anyway, a rather controversial one, and perhaps inaccurate here and there, readers may find additional comments interesting.

The subject matter is very tricky and I only wish I were capable of understanding more about these seemingly basic laws. I recall fighting my way through a quantum mechanics course only to find electric fields are quantized, too! That's where I stopped!

Your magazine is very enjoyable, and has stimulated me to the point where this is the first letter I've written in response to an article in any magazine.

Ed Schweitzer

Dear Sir:

The article by Bill Hoisington, K1CLL, in the September 1969 issue of your magazine reflects the work of a good inquisitive and active mind, and I certainly agree that satisfactory explanations of quasars and pulsars are in short supply.

I recall a book written by a Mr. Dolbear, entitled *Matter, Motion and Ether.* The book was written around 1900, and Dolbear was a physicist at a university in this country, perhaps at Duke, but probably at Tufts University. It has been five or more years since I've seen the book, and it is not now available to me, and I apologize for the scanty details on the book and its author.

However, I recall he investigated the ether problem from a similar point of view, that is, vortex waves, or rings. I was intrigued enough to build a number of vortex ring generators and spent many days fascinated by their behavior. For example, one ring may be made to pass through another if they are directed on the same path but head on in exactly opposing directions. I also recall that a slight angle between the paths was sufficient to upset this amusing effect. Note that this is rather contradictory to the behavior of electromagnetic radiation.

After reading elsewhere that soldiers during the Civil War were reportedly observed to fall as the result of cannon blasts far from the soldier (this refers to some soldiers whose position was not coincident with the trajectory of the projectile), I

experimented with devices capable of producing much larger vortex rings than the coffee can devices could. I succeeded in extinguishing candle flames at 20 to 30 feet ranges with a ring about four or five inches in diameter. This was done in a college dormitory where drafts perpendicular to the propagation direction were uncontrollable. That the drafts interfered has more significance than making it difficult to aim my generator at a small, distant target.

Consider the experiments of Michelson and Morley in California around 1900. The ether mystery was one target of their classic and famous interferometer experiments. I refer to *Studies in Optics* by A. A. Michelson, where he describes the details of his work in relation to the controversial theories of the day. Any ethereal wind, perhaps as a result of the earth speeding along its orbit, should cause differences in propagation times along the legs of the interferometer. No differences were observed, a result strongly supporting the no-medium-necessary camp. Please recall how the cross drafts upset my vortex ring experiment, and note the conflicting but, I think, explained results.

The ether matter deserves questioning on other bases, but the proof is in Michelson's experiments. Basing theories on the postulation of an ether will lead to results as disastrous as the results for planetary motion based on an earth-centered system.

May I also comment on Mr. Hoisington's discussion of the unacceptable nature of the dual nature of light, i.e., waves and particles. In quantum mechanics, the wave-particle problem is attacked from a probabilistic point of view, and the results are in excellent agreement with observation. For example, radiation in quanta (photons) and Heisenberg's uncertainty principle are results predicted by quantum mechanics, and apparently not questioned by Mr. Hoisington.

At this point, where quantum mechanics and relativity are starting to merge on me, I stop. But the theory and confirming experiments from here on add more and more support to two points I've tried to illustrate.

1. There has never been evidence presented to support the existence of an ether.

2. A dual nature is evidenced in light when considered in terms of our concepts of particles and waves.

I hope I am not insulting by writing that I at first thought this to be an April QST type of article, and further hope that I have not been taken in on a spoof.

Edmund O. Schweitzer III WA3LPD/K9ZXE
3507 Lancer Drive
Hyattsville MD 20782

Ed. Note. Mr. Hoisington is quite earnest in his theories.

CW in Perspective

Sir:

For the last fifteen years of my life I have been directly involved in the field of electronics and radio; my duties have taken me from design to test, to maintenance sales and every other aspect of the field of electronics, not necessarily in the above order; a number of these years to the present time I have shared with amateur radio, and I must say, they have been most enjoyable.

My interest has been focused lately in the current controversy about the latest changes in regulations by the regulatory body of amateur radio, the FCC. I have followed with interest the opinions of different sectors of the "ham population" in the States, as well as reaction from outside the country, and when viewed individually, I think the arguments in favor are as strong as the arguments against them.

I, however, decided to look at them from a different point of view... The purpose of amateur radio in the United States as well as in most countries around the world, is one of "service to the community," "service to society," and self-improvement of the operator, in both technical and mental aspects.

The amateur frequencies in this country have been divided in several portions, where operations in one or other mode are permitted or restricted; mainly we can observe a lower part of a band of frequencies used for CW and another part being used for "phone" work, with some more divisions allowing certain privileges to certain classes of license. In order to qualify for them, prospective amateurs have to pass a test which will measure their ability and knowledge in the field of radio amateurism.

I have been very interested in the emphasis being placed on CW operation, higher and higher speeds are required in order to qualify for general, advanced or extra class; presumable we are assuming that this ability to operate the key at higher rates is a service to society or a way to improve the operator and prepare him for a better future... nothing could be further from the truth, and don't get me wrong: I have absolutely nothing against CW operation *per se*, like I have nothing against radio control or RTTY or any other form of expressing one's preferences in the field of radio, but I do feel that the unnecessary restrictions and regulations placed on the amateur community by these laws are repressing progress and producing an effect completely opposite to the one originally intended by the FCC. Let me make this clear, I am going to submit to you very convincing arguments that can be checked by anybody at any time, but I do not propose that we do away with CW operations; quite the contrary, all the amateurs that prefer this type of operation should continue to do so without any restrictions of any kind, but the emphasis placed on it should be channeled to some other fields of research more useful to society and the country.

For the past few months I have been researching industry, schools, and government agencies in the Western area of the USA, and sad as it may be, the consensus is unanimous, without exception: CW is a thing of the past, of another time, long gone. It seems that only the ham fraternity clings to it, it will not leg go—perhaps due to the FCC, perhaps due to the fact that we are stagnant, more probably a combination of both facts, the truth is that CW regulations are holding down progress in amateur radio, it occupies a great portion of our frequencies that could be used to research some more advanced means of communication and perhaps recover the leadership that we lost when Teletype and computers were given the job of transferring intelligence from one point to another.

A Los Angeles City School official told me that as far as he can remember, there was only one school in Los Angeles that ever had a course in telegraphy, and that course was discontinued a long time ago FOR LACK OF JOBS in the industry to place the graduates.

A head engineer for the telephone company told me that as far as he remembers, telegraphy is not being used nor had it been used for a long PERIOD OF YEARS.

Good old Western Union representatives told me that telegraphy was too slow and inefficient a way of communication to be used any more, he knows of no operation in the USA that uses CW, and he can remember none.

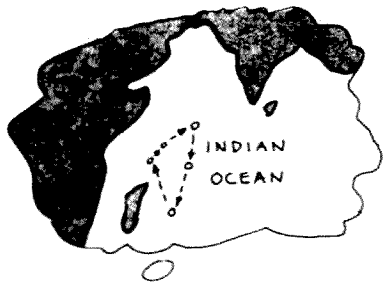
It seems to me that those are pretty conclusive statements, and a quick check around the country will show that conditions are the same. The question is: What are we being led to; are we preparing ourselves to serve the country in case of need; are we ready to be a service to society in case of emergency or are we preparing ourselves to provide a disservice to the community, with our antiquated practices; and perhaps eventually lose our frequencies to some other service that proves to have more foresight than we did. Are we getting ready to go to the planets and stars with our high speed: 25 words a minute; or should we be getting ready for a more sophisticated way to convey intelligence at *millions of bits per second* and more...

It is time that those who represent the amateur community, look at the future, at the present, and at our activities. Since the first wireless was turned on, we have progressed to the fantastic speed (new regulations) of 25 words per minute. It is time that we really make some progress, it is time that the FCC and the members of the regulatory bodies take a new look at amateur radio, the ARRL, the amateur publications; and all amateurs should express their opinions and views on the subject. The growth of amateur radio has come to a standstill, and it is our responsibility to do something for it, to give a new challenge to our group; it is the responsibility of its leaders to petition the FCC and Congress for the necessary laws and regulations to make our goal possible.

Edgar A. Romo HC2RP
7312 Mason Ave
Canoga Park CA 91306

DX AS SEEN BY...

Tom Orr W6EIF
249 Juanita Way
Placentia CA 92670

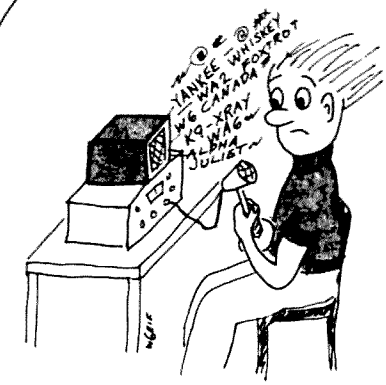




Gus



The QSL Bureau



The Rare DX Station



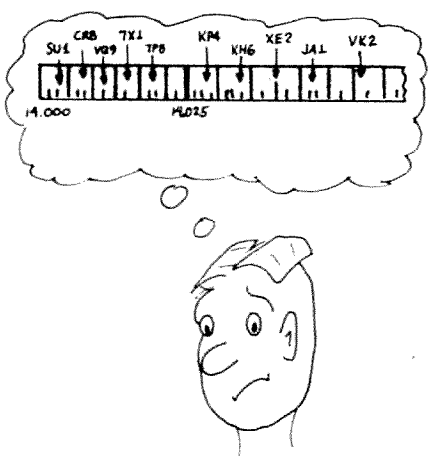
The DX'er



The Tower Manufacturer



The Novice

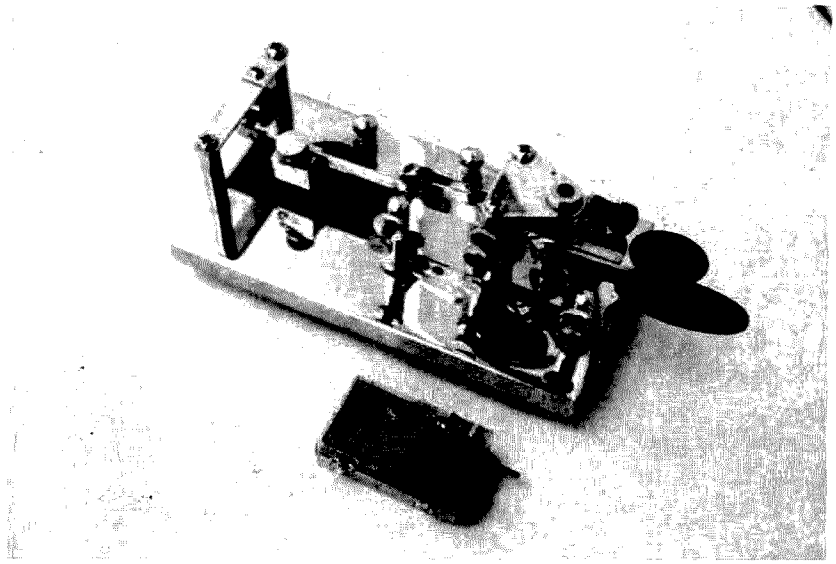


The General



The DX Station's QSL Manager

Lee Zipin WA3GGH
1013 Melrose Avenue
Melrose Park PA 19126



Micro-Mitter compared to a Vibroplex Lightning Bug.

MICRO-MITTER ... TEENSY-WEENSY QRP ON 40

In the March, 1968 issue of 73, an article was published entitled, "Mini-Mitter; the Ultimate in Miniatures!" Mr. Pyle suggested the possibility of having built the smallest CW transmitter to date. Several months earlier, however, I constructed a complete CW transmitter which, with the power supply, fits into the case that the crystal came in (for convenience, the crystal remains outside, plugging into an internal socket).

The circuit is a typical crystal oscillator circuit, using a 2N2188 transistor. The unit was built to operate on 40 meters, but with proper adjustments in the LC section and crystal value, any low frequency can be obtained. The parts are strictly junkbox, and the smaller the better. I used a miniature tuning capacitor from a junked transistor radio, and wound the coil so the pair would resonate at 40 meters. The battery is a watch-type mercury cell, with its socket made from two pieces of sponge rubber and wire contacts. Any suitable glue can be used to hold everything together.

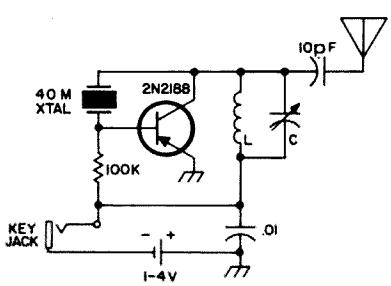


Fig. 1. Schematic of Micro-Mitter. L and C should resonate at the crystal frequency.

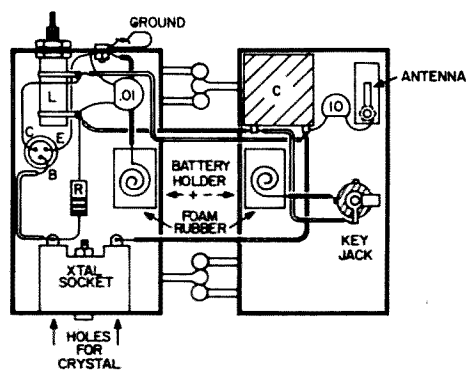


Fig. 2. Case layout. The case is opened on its back, and the battery is removed for clarity.

To operate the unit, attach antenna and ground wires to their respective clips. Push the key down and tune the variable capacitor for maximum signal (as indicated on your receiver—don't worry, it won't burn out the front end). I haven't measured input or output power on the rig, but I carried on a QSO with a station 50 miles away. Not bad for something you can lose in your shirt pocket!

... WA3GGH ■

PROPAGATION CHART

J. H. Nelson

February 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
(1)	(2)	3	(4)	(5)	(6)	(7)
8	9	(10)	(11)	(12)	(13)	14
(15)	(16)	(17)	18	19	[20]	21
(22)	(23)	(24)	(25)	(26)	27	28

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

	GMT	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA		21	14	7	7	7	7	7	7B	14	21	21A	21
ARGENTINA		14	7A	7A	7	7	7	14A	21	21	21	21	21A
AUSTRALIA		21A	14	7B	7B	7B	7B	7B	14B	21	21	21	21A
CANAL ZONE		21	14	7	7	7	7	14	21A	21A	21A	21A	21
ENGLAND		7	7	7	7	7	7	14	21A	21A	21	7A	7
HAWAII		21	14	7B	7	7	7	7	7B	14	21A	21A	21A
INDIA		7	7	7B	7B	7B	7B	14	14	7B	7B	7B	7
JAPAN		21	14	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO		21	14	7	7	7	7	7	14A	21	21	21A	21
PHILIPPINES		14	14	7B	7B	7B	7B	7	7	7B	7B	7B	7B
PUERTO RICO		14	7	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA		14	7	7	7	7B	14	21A	21A	21A	21	21	21
U. S. S. R.		7	7	7	7	7	7B	14	21	14	7B	7B	7
WEST COAST		21	14	7	7	7	7	7	14	21	21	21A	21

CENTRAL UNITED STATES TO:

ALASKA		21	14	7	7	7	7	7	7	14	21	21	21A
ARGENTINA		21	14	7A	7	7	7	7A	14A	21	21	21	21A
AUSTRALIA		21A	14	14	7B	7B	7B	7B	7B	14A	21	21	21A
CANAL ZONE		21	14	14	7	7	7	7	14A	21A	21A	21A	21A
ENGLAND		7	7	7	7	7	7	7B	14	21	14	7B	7B
HAWAII		21	14	14	7	7	7	7	7	14	21A	21A	21A
INDIA		7	14	7B	7B	7B	7B	7B	7	7	7B	7B	7B
JAPAN		21	14	7B	7B	7	7	7	7	7	7B	7B	14
MEXICO		14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES		21	14	7B	7B	7B	7B	7	7	7	7B	7B	14
PUERTO RICO		21	14	7	7	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA		14	7A	7	7	7B	7B	14	21A	21A	21	21	21
U. S. S. R.		7B	7	7	7	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

ALASKA		21	14	7	3	3	7	7	3	7	14	21	21
ARGENTINA		21	14	14	7B	7	7	7B	14	21	21	21	21A
AUSTRALIA		21A	21A	14	14	7B	7B	7F	7B	14	14	21	21A
CANAL ZONE		21	14	7	7	7	7	7	14	21A	21A	21A	21A
ENGLAND		7B	7	7	7	7	7	7B	7B	14	14	7A	7B
HAWAII		21A	21	14	7	7	7	7	7	14	21A	28	21A
INDIA		7B	14	7B	7B	7B	7B	7B	7	7	7	7B	7B
JAPAN		21	21	14	7B	7	7	7	7	7	7B	7B	14A
MEXICO		21	14	7	7	7	7	7	7A	14A	21	21A	21
PHILIPPINES		21	21	14	7B	7B	7B	7B	7	7	7	7B	14
PUERTO RICO		21	14	7A	7	7	7	7	14	21	21	21A	21A
SOUTH AFRICA		14	14B	7	7	7B	7B	7B	14	21	21A	21	21
U. S. S. R.		7B	7	7	7	7	7B	7B	7B	14	7B	7B	7B
EAST COAST		21	14	7	7	7	7	7	14	21	21	21A	21

A = Next higher frequency may be useful also.

B = Difficult circuit this period.

A Simple

Almost any integrated circuit operational amplifier can be used to build this Q-multiplier. Its advantages are extreme circuit simplicity and a useful frequency range that extends from audio frequencies to almost all i-f frequencies. Both the peaking frequency and Q can be made variable.

Both vacuum tube and transistor Q-multiplier circuits find wide application in improving the selectivity of transceivers and receivers, particularly on CW when the Q-multiplier is used to peak the i-f response following a steep-skirted crystal or mechanical SSB filter. The Q-multiplier provides a very narrow bandpass but if used alone does not provide steep skirt selectivity. When used in conjunction with an SSB filter, however, the latter provides the necessary skirt selectivity (see **Fig. 1**).

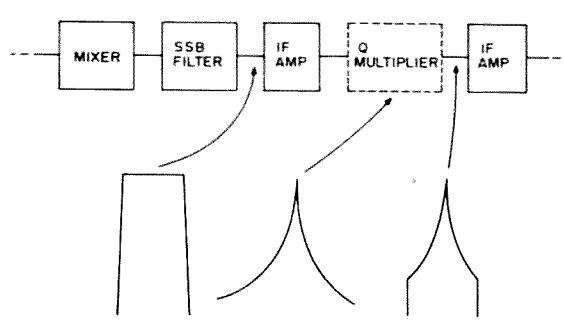


Fig. 1. Placement of Q-multiplier after SSB filter provides effective narrowband response for CW reception.

Integrated Circuit Q Multiplier

John J. Schultz W2EEY
1829 Cornelia Street
Brooklyn NY 11227

The Q-multiplier described in this article is meant to be inserted between any i-f stage in a transceiver or receiver following an SSB filter. It can be easily switched for broadband operation so it does not affect normal SSB operation. Since it is adjusted for unity gain, it does not upset any gain relationship in the i-f stages. As compared to vacuum tube and transistor-type Q-multipliers, the circuitry of the unit is extremely simple due to the use of an integrated circuit operational amplifier. The unit can be successfully used on frequencies far higher than those normally used with vacuum tube or transistor Q-multipliers up to 5 MHz or more, depending upon the integrated circuit used. The circuit can also be used at audio frequencies, if desired. One can also build an audio selectivity unit for outboard use when it is not desired to make internal modifications to a transceiver or receiver.

Circuit Description

The Q-multiplier is constructed around an integrated circuit operational amplifier. Many such amplifiers are available on the market at prices starting at a few dollars. The main requirements for choosing a suitable unit are that it have a differential input (inverting and noninverting inputs), and a single-ended output and a bandwidth sufficient for the frequency of operation. For example, Fairchild 709T amplifiers are available for about $3 and are usable up to at least 500 kHz. I built a unit using a Fairchild 741 which is usable up to 1-2 MHz. Other amplifiers such as a Motorola MC1530 can be used up to 10 MHz.

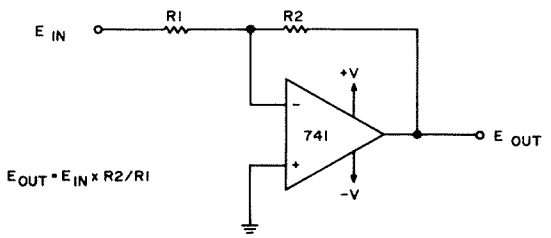


Fig. 2. Basic type of integrated circuit operational amplifier with a differential input and single-ended output that is needed for the Q-multiplier circuit.

Figure 2 shows the schematic of the type of operational amplifier which is used and the formula for the output voltage of an ideal amplifier. The Fairchild 741 amplifier which I used requires no external frequency compensation components. Other amplifiers may require a few external components for this purpose as specified on their data sheet. The frequency rolloff components should be chosen such that the amplifier gain starts to decrease just above the frequency where it is used as a Q-multiplier. There is no advantage to having the gain "rolloff" at any higher frequency and would just make the amplifier more susceptible to oscillation due to a stray feedback path via external components. As noted from the gain formula, the gain of the amplifier depends upon the ratio of R2 and R1. If R2 is made equal to R1, the gain is unity. The Q-multiplier effect is based upon replacing R2 with a parallel resonant circuit which will present a very high impedance at one frequency and, therefore, maximize the overall gain at that frequency. Positive feedback is also used to enhance the Q-multiplying effect of the circuit.

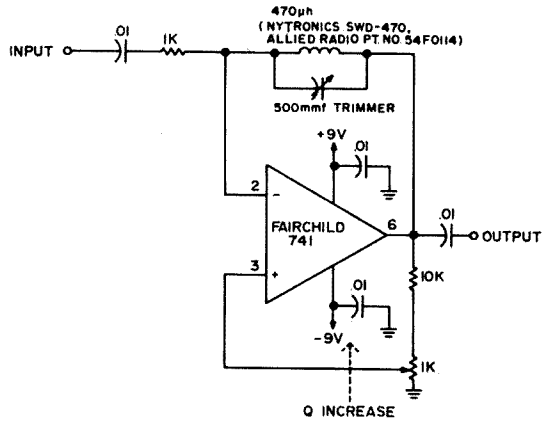


Fig. 3. Circuit of the Q-multiplier as constructed for a 455 kHz i-f

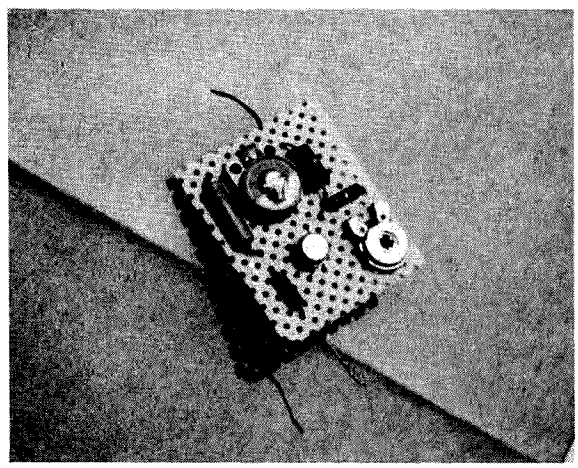
Figure 3 shows the schematic of a practical Q-multiplier circuit with the LC circuit resonant at 455 kHz for use in a 455 kHz i-f chain. Positive feedback is supplied via a 1 kΩ potentiometer. As with other Q-multiplier circuits, the Q can be increased by regulating the feedback until a point is reached when the unit will break into oscillation. The Q-multiplying effect is most effective when components are used for the resonant circuit which in themselves have a good Q. The inductor used for the 455 kHz Q-multiplier is a molded type which provides a Q of about 55 at 455 kHz by itself. The circuit can multiply this value by about 50 times or more. Another suitable inductor can be obtained by using only one or two sections from a regular 1 mH rf choke. The trimmer capacitor is used to set the frequency of the Q-multiplier in the middle of the i-f passband. It can, of course, be used as a variable tuning control for the peaking frequency of the unit. The input resistor, although shown with a nominal value of 1 kΩ, should be chosen so that the gain of the overall circuit is approximately unity.

Construction and Adjustment

There is nothing critical about the construction of a unit utilizing the circuit described as long as the various lead lengths are kept short. The photograph, for instance, shows how the various components can be directly wired together on a small piece of Vector board. The board itself can be directly mounted near the i-f chain in a transceiver, receiver, or together with the potentiometer used for feedback control if the latter is panel mounted.

If the Q-multiplier is not made tunable, the initial adjustment consists of peaking up the LC circuit. This can be done with the unit connected in an i-f strip and using any test signal centered in the i-f bandpass. The adjustment is best done with the feedback control set for minimum Q and with a barely audible CW test signal. The input resistor value should be then chosen for approximately unity gain. The adjustment is not difficult and need not be made exactly. The output level produced by a test signal without the Q-multiplier connected is noted. Then when the Q-multiplier is used, the input resistor is chosen so that the output level remains approximately the same. With most transistor i-f stages, the value of the resistor needed will be about 1-5Ω.

Bypassing of the Q-multiplier can be done in a number of ways in order to allow for normal SSB reception. If the Q-multiplier is made frequency tunable, it can simply be tuned outside the i-f bandpass. In order not to have the i-f gain decrease too far when doing this, the input resistor must be chosen for unity gain to take place when the Q-multiplier is just tuned outside the i-f bandpass. This will result in some increase in gain when the Q-multiplier is tuned to the center of the i-f bandpass but normally the



The Q-multiplier components can be directly wired together using Vector board mounting. In this case, a PC board potentiometer is used to set the operating Q rather than making it continuously variable.

result will not be objectionable. Another way to bypass the unit is to replace the LC circuit with a simple resistor equal in value to the input resistor (as in **Fig. 2**). The switching action can be accomplished by using a 1 kΩ potentiometer for the feedback control which also incorporates a SPDT switch. The switch must be wired such that the resistor replaces the tuned circuit when the wiper arm of the potentiometer is at ground potential.

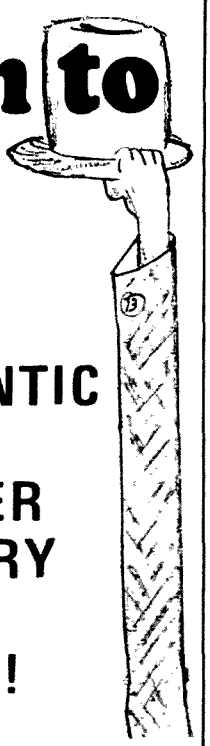
Summary

The simple Q-multiplier circuit described can be used for a variety of purposes besides that of improving i-f selectivity. It is useful for improving the Q and selectivity of a variety of tuned circuits as they might be used in FSK converters, audio filters for distortion tests, etc. Stagger-tuned circuits used in series can be formulated to provide a variety of bandpass shapes, often replacing more expensive components where bandpass shape factor is not important.

The permission of Dick Gerdee of Optical Electronics to present this circuit, which he originally developed, is gratefully acknowledged.

. . . W2EEY ■

hold on to your hat!



THE GIGANTIC FM REPEATER DIRECTORY IS COMING!

It's new and fresh . . . it's accurate and up-to-date. And best of all — it's free to 73 subscribers.

QUICK STOP & REVERSING For Antenna Rotator

My antenna rotator is a homebrew type made with a 1/3 hp motor. An early problem I notices was that the rotor had a tendency to keep turning for a few degrees after the stop command. So I use a discharge of capacitors in the motor as an electric brake. I also applied this technique to a small lathe that I bought to build 432 MHz cavities. It works great. When used in the

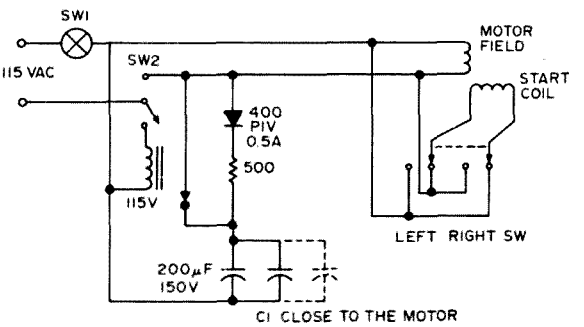
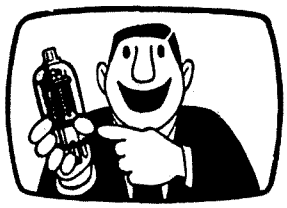


Fig. 1 Extra contact in the go switch

antenna rotator, the brake also provides an instant reversing capability. You need only an extra contact in the off-one switch to command a heavy duty relay near the rotator. When you are turning the antenna, the silicon rectifier charges a bank of capacitors, and when you stop, the condensers are discharged in the motor, bringing it to an instant halt. Put the capacitors in one by one until you get instant stop with your motor. (It is not good for dc motors.)

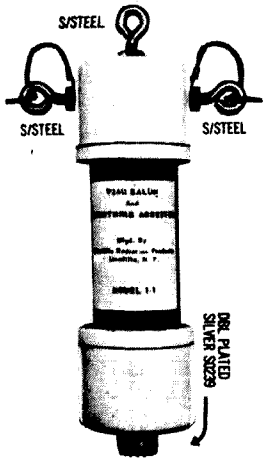
. . . Jose Vicente **PY2AUC**■



NEW PRODUCTS

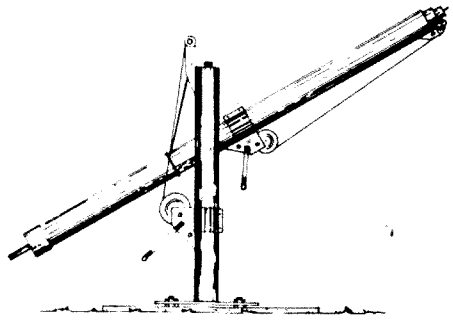
Hi-Power Balun Offers Lightning Protection

The *Big Signal* W2AU balun comes in either 1:1 or 4:1 conversion ratios, and boasts a full kilowatt (the California kind) capability, built-in lightning arrester, and a bandwidth of 3 to 40 MHz. Manufactured and distributed by *Unadill Radiation Products, Unadilla NY 13849.*



Crank-Up Mast has Tiltover Feature

Tristao is now marketing a crank-up mast. The two-section mast goes to 49 ft and the three-section version reaches a towering 66



EASY 2 STEP INSTALLATION

ft. The rotator rests right near the ground, simplifying service of this mechanism. The complete system (called Magna-Mast) can be installed entirely by one man. The tiltover mast enables work to be done on the antenna from the ground, a safety feature which should appeal to amateurs with weak hearts. Both models are hot-dipped galvanized steel. Drop a note to *Tristao, Box 115, Hanford CA 93230.*

Swan Develops Bandpass Antenna For VHF Bands

The Swan bandpass antenna, developed for use in home television reception, has recently been adapted for the 2 and 6 meter amateur bands. Swan's bandpass antenna has the combined properties of constant impedance match across the entire passband of response, with gain superior to that of an equivalent-sized yagi. The antenna features a very high front-to-back ratio as well as front-to-side in both the X and Z planes. Match is in the order of 1.1:1, and gain across the entire design bandpass remains virtually constant.

The Swan bandpass array uses four driven elements, and saturates the first director with virtually all of the power radiated from those active elements. Since the first director sees four driven elements at four different distances, it responds to the designed bandwidth, giving gain at four different frequencies, hence the bandpass response. Similarly, each dipole is matched to four separate frequencies, giving a constant impedance match across the design bandpass.

The advantages are:

- Controlled bandwidth response
- Controlled bandwidth impedance
- Rejection of undesired frequencies and noise above and below desired bandpass response
- Unidirectional response
- Improved signal-to-noise ratio
- Greater gain than the yagi array for the size

The bandpass antenna is a product of the *Swan Antenna Company, 646 N. Union St., Box 1122, Stockton CA 95201.*

Portable Checker Tests FET Gain, Leakage

The Model FT155 is an FET tester designed for easy use by technicians. Field-effect transistors, like vacuum tubes, cannot be checked out on a conventional transistor tester. The FET is measured like a cold vacuum tube and requires charts that



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measure the gain in transconductance and leakage in different terms than a regular transistor. Use is not limited to the service trade but is expected to fill the need of the many industrial technicians and engineers who can now test transistors but cannot check the FET. *Sencore, Inc., Addison IL 60101.*

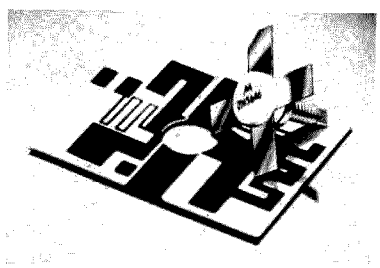




12V Power Transistors for 450 MHz FM

A chain of balanced-emitter rf power transistors is capable of providing 12W in the 450 MHz band with a 12V supply. The new transistors, 2N5644 through 2N5646, are intended for use as power amplifier stages of mobile transmitters in the UHF FM band. The 2N5646 family is supplied in the popular 3/8 in. ceramic stripline opposed-emitter package. Wide, low-inductance leads provide easy design and adjustment, especially in broadband circuitry.

An important feature of the new transistors is their balanced-emitter construction: Each unit is composed of many monolithic transistors in parallel, with a thin-film Nichrome resistor in series with each emitter. If current should increase in any one of these transistors, the rise in voltage across the emitter resistor will decrease base-to-emitter voltage, reducing the current flow. The equivalent parallel resistance of all the resistors is very low, hence does not cause significant degeneration. Because of the balanced-emitter construction, these transistors are very resistant to damage from mismatched loads or detuning. *Motorola Semiconductor Products Inc., Box 20924, Phoenix AZ 85036.*



The Motorola 2N5646 rf power transistor has an output of 12W in the 450 MHz band with a 12V supply. Balanced emitter construction makes device resistant to detuning and mismatching.

Semiconductor Book in the Printing

The just-released Motorola Semiconductor Data Book (Fourth Edition) provides specifications on all EIA-registered semiconductor devices, and complete data sheets on all discrete semiconductors manufactured by Motorola (3626 types). The 2160-page hard-bound and fully indexed book also includes useful selector guides, package and application information, and vital semiconductor statistics. *Motorola Semiconductor Products Inc., PO Box 20912, Phoenix AZ 85036.*

REGUL. PWR SPLY FOR COMMAND, LM, ETC. **PP-106/U:** Metered. Knob-adjustable 90-270 v up to 80 ma dc; also select an AC of 6.3 v 5A, or 12.6 v 2½ A or 28 v 2½ A. With mating output plug & all tech. data. Shpg wt 50#..... **19.50**

BARGAINS WHICH THE ABOVE WILL POWER:
LM-(*) Freq. Meter: .125-20 mhz, .01%, CW or AM, with serial-matched calib. book, tech. data, mating plug. Checked & grtd..... **57.50**
TS-323 Freq. Meter: Similar to above but 20-480 mhz, .001%. With data..... **169.50**
A.R.C. R11A: Modern Q-5'er 190-550 khz... **12.95**
A.R.C. R22: 540-1600 khz w/tuning graph... **17.95**
A.R.C. R13B: 108-132 mhz w/tuning graph. **27.50**

HIGH-SENSITIVITY WIDE-BAND RECEIVER
COMMUNICATIONS. . .BUG DETECTION . . .SPECTRUM STUDIES

38-1000 MHZ: AN/ALR-5 consists of a brand-new Tuner/Converter **CV-253/ALR** in original factory pack and an exc. used, checked OK & grtd. main rcvr **R-444** modified for **120** v, 50/60 hz. The tuner covers the range in 4 bands and each band has its own Ant. input plug (type N). Packed with each tuner is the factory checkout sheet. The one we opened showed **SENSITIVITY:** 1:1 uv at 38.3 mhz, 0.9 at 133 mhz, 5 at 538 mhz, 4½ at 778 mhz, 7 at 1 ghz. The rcvr is actually a 30 mhz IF ampl. with all that follows an IF, including an S meter. Has Pan, Video & AF outputs. Has a calibrated attenuator in 6 db steps to -74 db, also AVC position. Select pass of ±200 khz or ±2 mhz. **AND SELECT AM OR FM!** We furnish Handbook & pwr-input plug, all for . . . **$275.00**

R-390/URR Rcvr: Collins xtl-synthesizing drift-less receiver, grtd **100%** perfect **795.00**

SP-600-JX(*) Rcvr: 0.54 mhz, the popular late-type Hammarlund Super-Pro, aligned, grtd, exc. physical condition too, with book . **325.00**

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Depot Spares for SP-600-JX: Pri. 95/105/117/130/190/210/234/260 v 50/60 hz. Sec. 1: 305-0-305 v, 150 ma. Sec. 2: 5 v 3 A. Sec. 3: 6.3 v 5A. Sec. 4: 7½ v, 3/4 A. Sec. 5: 7½ v, 1¼ A. Legend for pins is plainly marked. Herm. sealed..... **2.95**
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303 West Crescent Avenue
Allandale, New Jersey 07401

Magnetic Latching RF Relay

Development of a new single-pole, double-throw magnetic latching coaxial relay has been announced by Dow-Key. The relay, which measures approximately 2 x 2 x 3/4 in., will handle 50W CW or FM, 100W PEP at frequencies up to 1.2 GHz. The no-bounce latching feature of the new relay makes it especially suitable for satellite and other applications where power consumption is of critical importance. The maximum vswr is 1.3:1 at 12 GHz. Coil voltage is 26V (dc). *Dow-Key Co., Broomfield CO 80020.*



Scan Receiver has Lockout Feature

Among the first in a new series of 2 meter FM receivers that provide autoscanning, the Kris also contains switches that allow channels to be skipped over in the scanning process.



The autoscan receiver samples 7 channels, sequentially and continuously, and "locks on" whenever a signal appears on one of the 7 channels. The scan rate is 20 samples per second. Crystals are not included in the $149 price. *Kris, Inc., 1026B S. Washington Ave., Cedarburg WI 53012.*

5-Element Single-Band Beam Offers High Gain, Low SWR

The *"Classic 20"* is a 20 meter single-band beam featuring the Classic Feed System (Pat. No. 3419872). An improved electrical balance, "Balanced Capacitive Matching," combines with optimum spacing to provide maximum gain, increased bandwidth, and more efficient performance than other antennas of its class. The rugged construction typical of all Mosley beams is incorporated into the *Classic 20*: high-impact insulators and clamping blocks, aluminum tubing, and stainless steel hardware.

Specifications:

Power rated: 1 kW AM/CW; 2 kW PEP SSB
Forward gain: 9.8 dB (11.9 dB over isotropic source)
Front-to-back ratio: 20 dB
SWR: 1.5:1
Feedpoint impedance: 52Ω

The *Classic 20* is a product of *Mosley Electronics Inc., 4610 N. Lindbergh Blvd., Bridgeton MO 63042.*

Electronic Keyer has Multiple Functions

In addition to providing perfectly formed and spaced characters when used with a paddle or squeeze key, the EK-38 "Electronic Fist" provides semiautomatic keying with a straight key or a "bug" for use



on-the-air or as a code practice oscillator. Power supply, sidetone oscillator, and speaker are built into the small attractive cabinet. Sidetone pitch and volume controls are provided as well as momentary and locked TUNE switches. A jack is provided for an external manual standby key. *Curtis Electro Devices, Box 4090, Mountain View CA 94040.*

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CV-253/ALR 38-1000 MC TUNEABLE CONVERTER
Excel. Cond. Late Model..... $150.00

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190-550KC Q-5er Good Condition.....$14.95
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1.5-3MC Marine Band Exl. Condition.....$19.95
3-6MC 75&80 Meters Exl. Condition.....$14.95
6-9MC 40 Meters Good Condition.....$14.95

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AN/FGC-IC Dual Diversity Audio RTTY Converter can be used with any type receiver. These are new and shipped in original factory crates with all spares.....$149.50

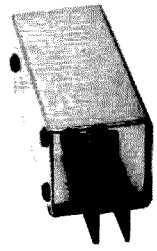
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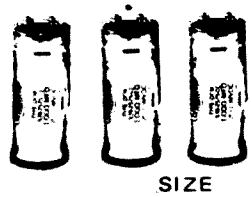
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5,500 MFD	45 VDC	2" x4½"
11,000 MFD	19 VDC	2" x4½"
11,500 MFD	18 VDC	2" x4½"
12,500 MFD	16 VDC	2" x4½"
10,000 MFD	15 VDC	2" x4½"
14,000 MFD	13 VDC	2" x4½"
15,000 MFD	12 VDC	2" x4½"
15,500 MFD	10 VDC	2" x4½"
15,000 MFD	10 VDC	2" x4½"
25,000 MFD	6 VDC	2" x4½"
30,000 MFD	10 VDC	3" x4½"
60,000 MFD	5 VDC	3" x4½"
20,000 MFD	15 VDC	2½" x4½"
15,000 MFD	15 VDC	2½" x4½"
35,000 MFD	12 VDC	2" x 6"
7,000 MFD	13 VDC	1 3/8" x4½"
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★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

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RTTY PICTURES FOR SALE. Vol. 1—$1.00; Vol. 2—$2.00. Audio and perforated tapes available. W9DGV, 2210-30th Street, Rock Island IL 61201.

HAMFEST. Announcing the 8th Annual WCRA Mid-Winter Hamfest. February 15, 1970 at DuPage County Fairground, Manchester Rd., Wheaton IL. Open 9 a.m. to 4 p.m. Tickets $1.50 at the door. Some space available for your own table. Further info write Box QSL, Wheaton IL.

T.O. KEYER A-1 condition, $20. New paddle for keyer, $10. Both $25.00. Michael Windolph, 3649 E. 65th St., Cleveland OH 41105.

SELL SB300: with SSB-CW-AM filters and 2 meter converter, $200 or best offer. HX-20, $95. Gary Tater, 40 West St., Leominster MA.

SWAN 250 with AC supply and Shure 444 mike. All mint condition. $250 FOB. No trades. McCormack, 5008 N. Carlyn Spring Road, Arlington VA 22203.

DRAKE R-4A, T-4X, and AC-3. Perfect condition. All three for $400. TH-6, Cliff Dweller and Ham M. All three for $150. Also Misc. accessories. All in great condition. Stan Towne, 878 Thackery, Highland Park IL 60035 (312-433-4472).

TOUCHTONE DIAL equivalent from Denmark. Ten button, convertible to all twelve in a minute with data included. Beige, except green and white while they last. 12 vdc required for oscillator operation. $15.00 postpaid USA. WB6WIM, 6606-5th Street, Rio Linda CA 95673.

COLOR ORGAN KIT, three 200 Watt Channels—$7.50; cabinet—$8.50; power supplies—$2.75 to $8.50; ceramic capacitors—$.10; dual flasher 1000 Watt—$3.98; 1000 resistors, 1/2 Watt, 1/2" leads—$2; TV cheater cord—$.25. Catalog. Murphy, 204 Roslyn Ave., Carle Place NY 11514.

SUPER GAIN (R) ANTENNA much gain, makes exciter sound like linear. See pgs 8 & 144, Oct. 73. GUERILLA (R) high efficiency ant. See pgs 57 & 113, June 73.

DAYTON HAMVENTION April 25, 1970: Sponsored by Dayton Amateur Radio Association for the 19th year. Technical sessions, exhibits and hidden transmitter hunt. An interesting program for XYL. For information, watch ads or write Dayton Hamvention, Dept S, Box 44, Dayton OH 45401.

GREENE. . .center dipole insulator with. . .or without balun. . .see 73, November '69, page 107.

RAGS HAMFEST Syracuse, New York, April 12, 1970 at Song Mountain, Box 88, Liverpool NY 13088.

FOR SALE: HEATHKIT Apache transmitter and Mohawk receiver. Will sell both for $300 plus shipping. Write: M. Albert, Box 12, Andover ME 04216.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class license, plus "Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

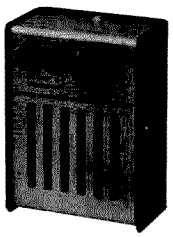
RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

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"TOWER HEADQUARTERS!" 11 brands! Heights aluminum 35% off! Strato crank-ups, low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog—$.20 postage. Brownville Sales Co., Stanley, WI 54768.

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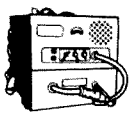


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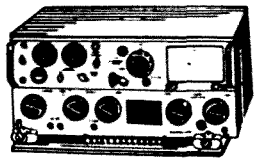
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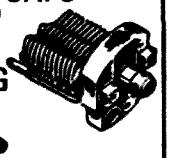
AN/ART-13 100-WATT XMTR
11 CHANNELS 2 to 18.1 Mc
200-1500 Kc



Collins Autotune Transmitter, extremely stable and suited for side band. Written up in QST Oct. issue, 1963. These are in boxes & crates as received from the Gov't & we will ship them out "as is" with no guarantee. They are supposed to be complete & with tubes. We are not even going to open the boxes and will simply stick a label on them and ship them out. We must make room for incoming material and our loss is your gain.
#ART-13 ..... $15.00

HAMMARLUND APC CAPS

Midget style, brand new, 4.5-100 mmfd.
3/$1.00 ..... 12/$3.50



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TOROIDAL CORES

Insulated powdered iron core about the size of 25¢ piece. Very low inductance, hi-freq. Wind your own transistor xfmrs.
#A-70. . .5/$1.00 ..... 30/$5.00

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Thordarson #22R44 brand new, produces 15KV pulse. With spec sheets.
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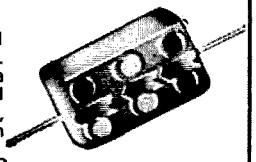
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TRANSISTOR MOUNTING PADS

Round fibre glass insulating pads, used under 3 legged TO-5, TO-18, etc. Raises and insulates transistors from PC board. Permits longer leads to be used with less danger of heat destruction. Adds professional touch to finished circuits. Bag of 50 pre-drilled pads.
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Misc. assortment of CM type small silver micas. Supply varies & will give a mix of available on-hand stock. Unused, long leads, standard codes stamped on each.



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CHRISTIAN Ham Fellowship now organized for Christian hams who wish to fellowship with other Christian hams. Request free information how to witness to other hams. Christian Ham Callbook $1 donation. For free details on organization write Christian Ham Fellowship, PO Box 218, Holland MI 49423.

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TM-73

NOT-TOO-TECHNICAL MANUAL

RADIO SURPLUS A LA 73

CONVERSIONS ET CETERA

RESTRICTED. This annual catalog issue contains hobbytype projects developed expressly for radio amateurs; any other use constitutes a flagrant show of interest in 73, THE WORLD'S LARGEST INDEPENDENT HAM MAGAZINE.

NOT AFFILIATED WITH THE
WAR DEPARTMENT

MARCH 1970

73 MAGAZINE

#114, March 1970

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A bunch of people (listed at the left) worked far beyond the call of the almighty dollar to make this the biggest, best, most attractive issue of 73 yet published. They hope you notice. They are working on the Big April Special FM Repeater Issue which will carry the most complete and up-to-date listing of the over 300 amateur FM repeaters in the U.S. They solicit your help in getting interesting items for the Amateur News Page, the first ham newspaper of its kind. You're not on FM yet? You will be.

Amateur Radio News Page

Subbands Reallocated in FCC Action

Amendment of FCC Rules Adopted To Shift Frequencies and Emissions In the Amateur Radio Service

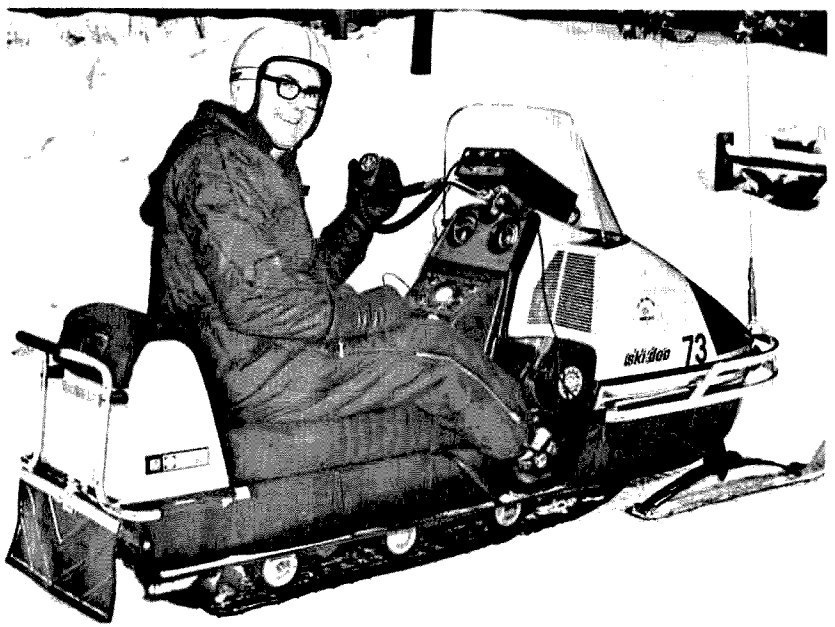
Amendment of Section 97.61 (a) of the Rules shifting frequencies and emissions in the Amateur Radio Service to the subband where A-1 emission is exclusively permitted from the 147.9—148 MHz band to the 144.0—144.1 MHz band; and shifting the subband where F-1 emission is permitted from the 29.0—29.7 MHz band to the 28.0—28.5 MHz band, has been adopted by the Commission, effective March 2, 1970 (Docket 18508, RM-886, RM-950).

The amendments were originally requested by the American Radio Relay League (ARRL). A Notice of Proposed Rule Making in the matter was released on April 3, 1969, (FCC 69-313), inviting interested persons to file comments on or before June 11, 1969, and reply comments on or before June 23, 1969.

Cl

Comments in support of the changes were filed by the ARRL, the Electronic Industries Association (EIA), Central States VHF Society (Central), and Forrest A. Bartlett (W6OWP). A comment filed by Donald R. Nelsch (K8EIW) supported adoption of the proposal in RM-886, but requested F-4 emission to be included in the 144.1 to 148.0 MHz frequency band. A comment filed by Howard McCall (W8TNF) was the only one which opposed adoption of the proposal in RM-950. No reply comments were filed.

SNOWMOBILE "MOBILE"... a first?



Bill Loeffler W1PFA Salem N.H. combines ham radio with the new popular sport snowmobiling. With a Galaxy FM 210 and Antenna Specialists 2 meter gain

CD Group Goes 2 Meters - FM

Bill Loeffler, W1PFA radio officer for the town of Salem, N.H. recently announced the RACES section of Civil Defense has planned to purchase 10 Galaxy FM 210 units of local communications. Recent tests made with the units proved the town to be neatly covered with mobile operation to base station with no blackout area whatever. Don Alexander W1UFK and Tony Coco K1ILB, communications officers for the town, feel that channelized operation on the 2 meter FM band, will greatly advance the local operation. Salem is expected to be the first RACES operation in New Hampshire to go FM.

YA Club Formed, Award Offered

Group standardizes prefixes

Since there is no licensing authority in Afghanistan, amateur operation in that country has been somewhat confused in the past. Amateurs have mere-

In its comments, ARRL pointed out that the 144.0—146 MHz band was assigned to the Amateur Radio Service on a world-wide basis, and that the 146.0—148.0 Mhz band is authorized to the Amateur Radio Service in Regions Two (Western Hemisphere) and Three (Southern Asia and Oceania), and to the fixed and mobile services in Region One (Europe, Africa, and Northern Asia); that while the 144.0—146.0 MHz band is specifically authorized for amateur satellite operation, the present 147.9—148.0 MHz, reserved for A-1 emission, cannot be used in Region One. The proposed 144.0—144.1 MHz band may, however, be used world-wide. Canada also has set aside 144.0—144.1 MHz for A-1 only operation.

The Commission said it believes that "clearing a portion of the 144—146 MHz band is desirable for continued experimentation in space techniques by amateurs."

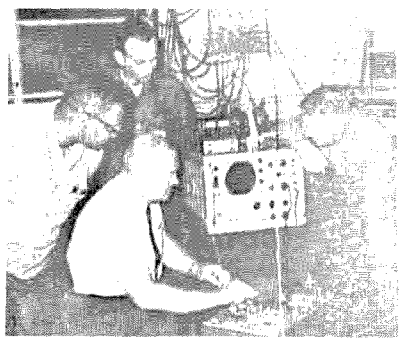
Central commented that, although it supported the proposal, the Commission was not going far enough. It stated that "the assignment of the first 100 kHz of the 144 MHz Amateur band to A-1 emission is at best a stop gap measure . . . " and that additional protection of experimentation may be required in the future. The Commission said, however, that the evidence submitted by Central is "insufficient to persuade us that a larger subband is needed and should be authorized at this time."

In reference to the suggestion made by Mr. Nelsch that F-4 emission be included in the 144.1—148.0 MHz amateur band because of the availability of facsimile equipment of commercial quality, the Commission said that this request is beyond the scope of this proceeding. It added, however, that the matter is the subject of a separate petition for rule making (RM-1429) filed by James L. Turrin (WA8DCE) and would be considered when that petition comes before it.

C

Howard McCall told the Commission that he disagreed with the proposal in RM-950 to relocate F-1 emission in the 28.0—28 MHz frequency band because it would result in a loss of 200 kHz for this type of transmission. Although the proposed relocation would result in a reduction of 20 kHz of bandwidth available for F-1 emission, the Commission said it believes this loss is "not extensive and is outweighed by the advantage of moving radioteleprinter emission (F-1) into the CW portion of the 28 MHz band."

Finally, the Commission stated that it believed that the shift in frequencies would not affect the operation of its users significantly.



FUCHU AS, Japan — Members of the Far East Auxiliary Radio League in Japan receive a demonstration of manufacturer's performance specifications versus actual performance in electronic equipment by Mark Radke (seated) of the U.S. Army Depot Command, Japan. Watching the demonstration are (from Left) Skip Brady, KA2SB/WB6RBI, Ed Frazier, KA2ZD/WA0ZZD, and Bill Ross, KA2DK/K5LLK, league president. The league is composed of U.S. military personnel in Japan with an interest in amateur radio. The group promotes activities of KA stations in Japan and fosters goodwill in the Far East and throughout the world through the medium of amateur radio.

Allied has free classes

Allied Radio Corporation will begin its annual Novice amateur radio license course on January 19, at the main Allied store, 100 N. Western Ave., Chicago.

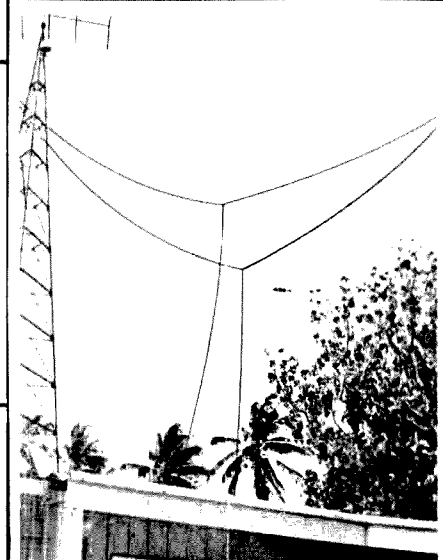
The free 14-week code and theory course will meet each Monday evening to help prepare would-be hams to take the Novice FCC license examination. The course will be taught by one of Allied's staff of licensed radio amateurs, with the major emphasis placed on learning the code.

antenna mounted on front of Ski Doo, Bill works into the W1ALE repeater at Concord, N.H. Power for the rig is taken from the cigarette lighter socket on Ski Doo. The snowmobile is a Bombardier Ski Doo Nordic 640E. Bill is also a member of the Salem, N.H. S-Ki-Mos snowmobile club. The 73 on front of the 'mobile is Bill's registration number in the Salem S-Ki-Mos club; there are 85 members.

W1TNO (Ted) in Concord, N.H. reported that he worked W1PFA/snowmobile in Salem, N.H. in late January. Bill was out with the local snowmobile club, with some 90 snowmobiles, running a test to check on the emergency use of FM via the repeater. The test worked perfectly, easily turning on the W1ALE repeater in Concord, some 40 miles away. Is this the first repeater FM operation from a snowmobile?

FCC Nails Ham for "Fraud"

In a public notice issued on January 16, 1970, the FCCrevoked the license of Herbert L. Rippe W8DE. According to the report, Rippe had obtained his two-letter call by "fraudulent" means, in violation of Section 97.129 of Amateur Rules and Regulations, Part 97. His revocation was made effective as of February 16.



ly brought in their equipment, set it up, picked out a call they liked, and gone on the air, hoping that no one would get upset in the government.

A little order is appearing out of the chaos now with the formal organization of the Camel Drivers Radio Club, organized by YA5RG. The country has been broken up into nine prefix districts, and the club will endeavor to get all ops to abide by them. This may be helpful and will certainly go a long way toward preventing one op from coming to Kabul and using ten different number prefixes in order to generate more DX activity, giving the impression that he is actually moving around the country.

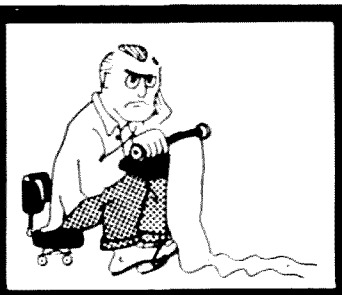
The club is offering the *Afghanistan Radio Award* to all amateurs and SWLs of the world. Contacts must be confirmed on at least two amateur bands and six contacts are required for YA amateurs, four for Asian amateurs (except YA), three for Europeans, and two for the rest of the world. Send QSLs and 10 IRCs (or one dollar), contacts from 1966 on count, to CDRC, Box 279, Kabul, Afghanistan. Send an extra dollar for airmail return.

VK9KY ACTIVE FROM COCOS KEELING ISLE

One of the more remote spots in the world is Cocos Keeling Island, off the coast of Australia and south of Sumatra. The only active station on this island is VK9KY, operated by Ken Young, who is living on Cocos running the Ionospheric Prediction Service station. The tower is used for the vertical sounding of the ionosphere and the fixed beam on top of the tower is pointed at Sydney for the weekly reports to the home office.

The dipoles are used for contacts on 15 and 20 meters and are broadside to Europe, thus holding the signal down a bit toward the States. Ken is planning on putting up a groundplane, and may even be able to swing a wire beam in a stateside direction. There are, of course, no materials available on the island for building even a simple regular beam.

If you might be able to help Ken out with antenna materials, his address is Box 31, Cocos (Keeling), Indian Ocean via Perth, Australia. QSL to his manager VK2SG. He often can be worked on 20 meters around 1200Z, sideband. Stamp collectors will treasure the beautiful bird stamps from Cocos.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

Since I am sure that many readers must be pretty sick of reading about the ARRL in my editorials, I will ignore them completely this month except for a short answer to a letter.

The letter (from Paul Crilly WA1IND, 15 Rosewood Drive, Simsbury, CT) is quite critical of me for having bad things to say about the ARRL, which he considers a fine organization which has helped hams in countless ways. He feels that the amateurs are enthusiastic about incentive licensing and that I am afraid of progress and improvement of the quality of amateurs.

You might think, from some of my mail, that I have written editorials saying that the ARRL is run by a bunch of crooks, headed by Captain Klutz, a chap whose morals would make the Mafia blush and whose intelligence would hardly qualify him for admission to the Crotched Mountain Home for the Mentally Retarded. No matter what I may personally think, I have not written anything like that.

The ARRL was started by Hiram Percy Maxim, a genius, the son of a genius, and the grandson of a genius. It took genius to get something like the ARRL going. When Maxim died there was the usual fight for control by those of less than genius talent. Some day someone will write an honest history of the ups and downs of the ARRL, but so far all we have seen are self-congratulatory rewrites of history.

Though the League has fallen into the hands of those of less than genius calibre, the organization continues to provide many very valuable services to the amateurs it was founded to serve. Few of them, unfortunately, are completely above criticism. We have not historically seen much improvement in ARRL programs until the tide of public opinion has forced changes. In connection with this you might note that the voice of 73 is the only one not stilled by fearful publishers. I won't list the manufacturers who withhold their advertising from 73 in an effort to force us to run bland editorials, but they are large and well known, and conspicuous in their absence from the magazine.

Perhaps I am deluding myself, but I can't recall running into a fervently anti-Wayne Green amateur that has read many of my editorials. When I talk with them I find that they are mad at me for things they have heard that I have written, not for what I have actually written.

Though I think of myself as a conservative, many readers seem to feel that I am a liberal. My reaction to incentive licensing is, I think, conservative. I feel that the ARRL management should have consulted the membership before petitioning the FCC for the rules change and I also feel that the whole idea would have been infinitely better if additional privileges had been offered for advancement rather than the punitive taking away of privileges from those who chose not to advance. It is basically the concept of using the stick or the carrot, with me favoring the carrot and ARRL the stick. You get more flies with honey than with vinegar.

A recent poll asked 73 readers if they thought amateur radio should have a lobby in Washington. The response was almost 100% in favor, yet the probability of anything like this happening seems remote. Why? The ARRL management certainly recognizes that such a lobby is not only needed, but is of critical importance to our future, yet they continue to do everything in their power to keep the directors from bringing it up at Board meetings. How come? As one of the HQ small fry explained it to me, the management feels that if a lobby is started in Washington there will be no way to keep the headquarters from eventually being moved to Washington, since HQ would have to follow the action. They don't want to move. They have nice houses, friends, and are comfortable in Newington where they are. As long as they can keep the Washington lobby cooled they can live on undisturbed.

But what of amateur radio, you ask? Since few of the ARRL management have been active amateurs in many years it is not really surprising at their seeming lack of emotional involvement with the hobby. I get a strong feeling that this is strictly a business matter with them and nothing more. They try and have business interfere with their personal lives as little as possible.

You might contrast that with the involvement at 73. Mike, Ken and I spend a good part of our waking hours working at 73 (or hamming), seven days a week. You will seldom not find at least one of us on tap by 6a.m., and the work goes on into the night when deadlines demand.

No matter how much good the ARRL does, there are bound to be some bad things and if these are not discussed and exposed, how can they be improved? Bad flourishes in secrecy and dies in the open.

When I write about the ARRL I try and differentiate *between* the 75,000 members (including me) and the management running the show at Newington. Most of the bad things that are going on are attributable to this small group, not the members. Now, do you feel that there is anything wrong about discussing the problems we are having with what can best be described as amateur radio's unelected "government?" Am I being picayune when I criticize this group?

Down through the years I have spoken out many times in my editorials in support of many of the programs run by the League. It seems to me that it would be redundant to do this in every editorial. For the most part readers of this editorial are the same readers that have endured dozens or even hundreds of my past editorials, so I try not to repeat myself too often.

When I first started in amateur radio I, too, used W1AW for code practice. Of course there were not nearly as many alternatives in those days. Few amateurs sent at less than 13 per on the air, there were no Novices yet, and about the only choice was an Instructograph tape machine or expensive 78 rpm records. Now, with inexpensive tapes and LP records available, plus thousands of Novices on the air, the need for W1AW code practice is probably not as dramatic as it was 35 years ago, but thousands of would-be amateurs still tune in W1AW every year for the service.

There has been considerable criticism recently of the W1AW practice of just coming on and sending code or bulletins with no regard for those already on the frequency, but I suspect this may be due to one tactless operator rather than headquarters policy.

The short-haul limitations of amateur radio were responsible for the beginnings of the American Radio Relay League, since relaying was the only way to cover longer distances before the short waves were discovered. This still lives on in the dozens of traffic nets spread out around the country, an activity that is basic to the ARRL. Since I have never been an enthusiastic CW operator, my own experiences with traffic handling have all been on phone or RTTY, but I certainly never put down the fellows that love traffic handling.

Are We Afraid of Progress?

Since 73 is normally months or years ahead of the other amateur magazines in bringing new technical developments to the amateurs, our marks in "progress" should be okay. The high density of technical and construction articles in 73 should acquit me on "improvement of quality of amateurs."

Might I point out, too, that only 73 has run a technical study course to help you upgrade your license. Are we doing more to help improve the quality of amateurs than the ARRL? Speaking of which, whether we like incentive licensing or not, it doesn't seem about to go away, so perhaps it is time to sit down and start plugging through our Extra Class series.

You know, I suspect that if Maxim were running ARRL we would be good friends and working together instead of the present system whereby HQ seems to be doing everything in its power to undercut 73 and ignoring as long as possible the needs and wishes of the members.

ARRL November Board Meeting

Several letters have been received complaining about the directors meeting, pointing out that they spent thousands of dollars getting together, only to discuss trivia and to ignore the major problems facing amateur radio. Since I have decided not to be critical of the ARRL in any way in this editorial, I shall say nothing about the Board meeting except that those of you who have access to the January QST will find it fascinating to read the detailed minutes of this historic Board meeting starting on page 75.

Improvement?

Now, didn't you like that editorial much better than those rotten ones where I am critical of the League? If this turns out to be popular I may write an editorial avoiding critical comments on our esteemed competitors down in New York.

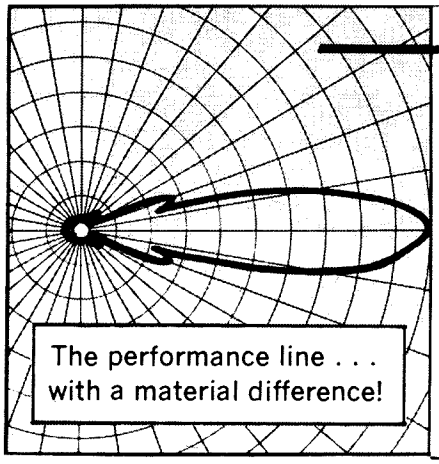
New Year's Present for Wayne

A daughter was born to my wife Lin just hours before the new year. Name: Sage Anetta Green. Your wives may be interested that we used the bubble all through pregnancy and during labor. The long term results are to be seen, but labor was quite easy and the birth was quick. The bubble, if you are not familiar with it, was invented in South Africa recently and provides a way for extra oxygen to get to the baby's brain during pregnancy, theoretically helping the brain to develop better and faster than without the oxygen. It also helps greatly during birth, providing the extra oxygen at this critical time, and easing delivery markedly.

Million Dollar TVI Suit Dies

We checked with Grid W4GJO and found that the TVI suit against him has been dropped. I am sure that the impressive backing Grid got from interested amateurs who sent donations to help with the fight had a lot to do with the dropping of this suit. If you have any illusions about what a great fight ARRL puts up for amateurs that get into serious legal difficulties such as this one, difficulties that could well turn into a nightmare for all amateurs if not fought to the bitter end, then just drop in at the Ham Shack in Sarasota and talk with Grid. You will find that not one penny of the thousands of dollars Grid spent on his fight came from the League.

Legal battles like this one might never get started if the complainant knew that the amateur he was suing would be supported financially all the way to the Supreme Court by the ARRL. The Institute of Amateur Radio did furnish cash for



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helping amateurs in legal difficulties, because one of its tenets was the belief that one ham's fight is amateur radio's fight. If the Institute could do this, so can the ARRL. The next time an ARRL director talks to your club, ask him about this . . .or write to him and ask. Get that ball rolling. Could you personally stand the $5000 to $50,000 that a suit like this can cost?

Band Occupancy

A recent study of the occupancy of our major bands during high density hours showed that the Extra Class segments are getting a lot more use than many of the underprivileged think. The survey, run by ARRL, and using about 100 amateurs as observers, might be more meaningful if it also covered medium and low density hours when the level of interference does not keep as many operators inactive that might otherwise be on the air. I suspect that the General bands fill up first, then the Advanced, and lastly the Extra. Full is full, and when all are full, then all are being equally used . . .right?

Free Advertising

Although we realized that 73 is very popular in colleges all around the country, we are flabbergasted at the strength of the student devotion. You may note, as we have, that pictures of college students with the "73" emblem on them are appearing in papers everywhere!

. . . Wayne ■

• • • •

VOX POP

Monthly Report of Activities on our Bands

There are a lot of interesting things going on in our bands that are all too poorly reported. Starting in April we would like to devote some space in 73 to reports of doings on the bands, with a separate section devoted to each amateur band and mode. Reports should be in our hands by the tenth of the month.

What's interesting? That depends upon the band, of course. Our 160m readers would like to know about DX tests, activities in rarer spots, nets, new counties activated, and any other organized activities on that band. Heretofore, there has been no good place to report something like this or any way to organize special interest nets, etc.

On 80m we have lots doing with the traffic nets, plenty of interesting activities in the Novice band, plus DX. I don't have in mind anything like the QST Station Activities column which lists who bought what new equipment and who passed along how many messages. But if TR8MC shows up on 3565 now and then, I think a lot of fellows would like to know about it. Up in the phone band there are a number of interesting nets that could well use some publicity now and then. When the Eyebank Net gets an eyeball to the right spot at the right time, that's news. When KR6AJ comes through regularly on 3808, that's news. When DX-minded ops manage to get the DX stations to tune up into the band for them, that's news. When a DXpedition is going to give the 75m gang a workout, everyone would like to know about it. I'm sure that the RTTY group on 80 has some news now and then that they would like to pass along...etc.

DX chasers will want to know the frequency, GMT, and QSL manager of rarer DX. We will pass it along, complete with the call of the fellow reporting the news.

On the higher bands I am sure that many of us want to know what is happening around the country on FM, TV, SSTV, moonbounce, satellites, meteor scatter, and other specialized branches of the hobby.

. . .W2NSD/1 ■

Modulated Vibrator Hash

AN EDITORIAL BY K6MVH KEN SESSIONS, JR.

In the past several weeks I have been doing a great deal of soul searching. My position as editor of 73 requires that I give full and adequate coverage – nonpreferentially – to all facets of amateur radio. Yet my personal involvement has been almost entirely with VHF FM and repeaters. As somewhat of a prominent figure in FM circles, I feel that I am under a special obligation to make 73 take up where FM Magazine left off. On the other hand, 73 has always represented the DX'er, the sidebander, the CW enthusiast.

So you see the embryo of a dilemma that has cost me more than just a few hours of sleep. The problem became even more dramatic when Mike Van Den Branden, former publisher of FM, joined 73. With the entire *staff* of the now-defunct FM journal at 73, a commitment to heavy FM/repeater coverage seemed even more necessary.

Good ol' Father Green gave me the answer. He came into my office, closed the door; and said something like, "Okay, it can't be all that serious ... We've got Blue Cross, your rent's paid up, and we all love you. So what's on your mind?"

I told him that I felt a special obligation – and need – to publish circuits, stories, features and news about the fast-moving and ever-changing field of FM and repeaters, but I couldn't justify slighting the other amateur modes in the process.

There would be no need to slight the other aspects of radio, he told me. And he solved my whole problem without so much as a wrinkled eyebrow. All we have to do, he said, is include more FM articles each month than the Journal did – and do it without sacrificing any of our regular content.

Simple solution ... just make 73 a little bit thicker. So that's what we did! Is that any way to run a magazine? You bet it is!

RM–1542

One year ago last January, FM Magazine published a tentative petition with regard to repeater rulemaking, and repeater owners were invited to submit comments and recommendations for changes. The purpose was to present a comprehensive rulemaking proposal to the FCC that reflected the combined ideas of all active FM people.

Shortly after the petition was published, suggestions began pouring into the editorial office. Then the League decided to take a hand, too. With the FM'ers going all out on the one side to get a meaningful set of repeater rules, the ARRL went off in another direction by appointing a staff of seven men to study the requirements of repeaters so that the League itself could make a recommendation to the FCC.

The League ignored the efforts already under way, and chose instead to make up its committee of staunch League members, *nearly half of whom have not participated at all* in the actions of the rulemaking group. Because of the apathy of part of the League's committee, some of the more conscientious members have become quite piqued, and are looking for a reorganization. Several members of the committee have not participated in any of the group functions, a fact that has stirred considerable controversy among the members.

One member of the League's advisory group has taken a more than passing interest in the problems, and is trying to pull the group out of its slump by actively campaigning for a set of proposed rules drafted as a result of recommendations based on comments from repeater organizations (particularly the California Amateur Relay Council) and, presumably, the original set of recommendations published in FM Magazine. That man is John J. O'Brien W6GDO, who is serving the dual role of ARRL repeater advisory committeeman and FM editor of Ham Radio. (I didn't think it was legal, since League President Denniston told me personally a year ago that I was ineligible for the committee because of my former association with FM Magazine.)

At any rate, O'Brien's rules have been reviewed by a number of active repeater groups, but they have not been adopted by the advisory committee. His recommendations are sketchy, but they appear sound and workable. The unfortunate thing is that his proposal is a long, long way from home. The advisory group must agree to accept it, following which it must be sold to League officials in Newington.

Meanwhile, hundreds of active FM'ers responded to the call for suggestions published originally in FM. These recommendations have been sifted and integrated, reworked and redrafted. Finally, one full year after the first draft was published, the final non-ARRL petition was submitted to the FCC. I personally submitted the petition, which bears identification number RM-1542, and will attest to the fact that it contains the ideas, recommendations, and constraints recommended by the collective body of active FM'ers.

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In case you're wondering what was in RM-1542, the essentials are listed in last month's "Modulated Vibrator Hash." If you're an FM'er and you *care* about recognition, licensing, and modifying the restrictions of repeaters, write the FCC now, and recommend quick action on RM-1542.

VIRGO

Probably every ham goes through the "cute phonetics" stage at some point early in his career. I started looking around frantically for something clever back in 1956 when I had a column in *Western Radio Amateur*, a west coast publication published by Don Williamson W6JRE. I wanted something snappy, like "Never Say Die," but my call, unfortunately, didn't end with "NSD." Quite coincidentally, during a late night QSO with my half converted military surplus transceiver, someone—I don't even remember who—commented that my signal was so raunchy it sounded as if I were modulating vibrator hash. The column title was born for me. It was something I was never crazy about, but it seemed reasonably apropos, so it stuck . . . through several amateur publications.

It wasn't until after I got to 73 and Wayne introduced me to someone as "Mr. Virgo himself," that I became totally disenchanted with the vibrator hash bit. After overcoming my initial depression resulting from the fact that I hadn't thought of the Zodiac tie-in myself, I elected to retire the tired "Hash" for good. From now on, I'll be Mr. Virgo Himself.

SPECIAL PEOPLE

Sometimes I think somebody ought to do something special for the "special people" in the ham radio business. The special people are those who manufacture and sell the gear we use. I've been around long enough to know that no one gets rich doing business with hams. Yet, as hams, we demand more of these fine folks than we'd expect of Sears or Montgomery Ward— and we get it!

I've lost track of the times I've pestered poor old Ted W6UOU at Henry Radio in Los Angeles. This rig didn't work right, or a part was missing from that antenna kit. Never a complaint or question. Always, the Henry people would make sure I was satisfied before I left the store.

My dad (Ken Sr., K6MQB) *really* puts them through their paces. He's an active ham with interests that change with the seasons. And he lives no more than a few blocks from Henry's L.A. store. He goes from 6 meters to 75...then he gets a yen for 15 and 20 sideband...it's beams and towers and quads...something for the shack, then something for the mobile. And each change means a trip to Henry, to check in the old gear and check out the new. I'm sure half the stuff he carts out of Henry's never even gets turned on. Everybody there pretty much knows him by name, and I suspect they don't even bother to write up the paper on half his purchases, knowing he'll be back in a week or two to trade it all in.

But they're good sports at Henry's—like they are at a lot of other stores where you and I and my dad buy gear. They may flinch when they see us walk in the door, but they don't show it, bless 'em.

...K6MVH FM

I spent this evening on the air, working old friends whom I haven't contacted in months. Now my antenna situation is cleared up I've been making up for all the time I've been struggling with limited means . . . dipoles mainly. After three or four contacts I got a call from a fellow in a nearby town. He has one of those shiny new two-letter calls, but he used to be an ordinary, garden variety K2 like the rest of us plain peasants.

"I've been reading your stuff in 73," he began. His tone was a little patronizing, as though he were at least the book reviewer of the Sunday Times. "It's pretty good," he says, "but I'd sure like to talk to you about one rock you pulled. I disagree with you completely on that one, Kid. I'm sure you didn't mean it the way it sounded, Dave."



This sounded serious and it piqued my curiosity. I asked him what part of the article he meant, but he demurred, saying he'd rather not discuss it on the air. He indicated that he would call me on the telephone, but did not wish to talk about it at present. I told him that I didn't mind his taking issue with what I had written...after all, the objective of a column like mine is to provoke thought and discussion. I never intended to write the sort of mealy-mouthed ambiguity with which everyone would automatically agree. I did not set out writing for 73 merely in order to put down on paper all those things which would justify widely held opinions, merely to bolster them. I added that sometimes an opposite opinion could serve to strengthen a reader's precepts and ideas, thus could serve two opposing viewpoints.

This particular column did not carry anything too terribly controversial, for I was merely trying to show how some topics might be handled innocuously. To be honest, the piece was written more or less jocularly, with no really serious objective in mind other than to illustrate the folly of outlawing particular subjects on the ground that they are in and of themselves unsavory and unwholesome. I thought to myself, "Perhaps he has taken exception to the part about religion. Many persons have rather thin skins on this subject, and consider it improper to discuss at all." When I asked him about this he said that it was not the part about religion.

By this time I was puzzled, and started pumping him. But he would not say anything more than he had already said. He simply changed the subject and would not "drop the other shoe."

Then I began to feel the pangs of annoyance. Why should I have to listen to what he had to say in the first place? He's not particularly qualified to do more than express an opinion, not being any sort of an expert, so far as I know. I'd gone over the column mentally in order to puzzle out what could have bugged him, but couldn't imagine what it was...unless it was the part about the pig farmer in Secaucus who ran for the Presidency so often. In my article I alleged that he could not have done worse than some of our recent Presidents, governors, and mayors. Maybe it was that apparent irreverence that annoyed him.

Now that I think of it, I tend to agree with him. I too am annoyed. I'm annoyed at myself for not saying that the pig farmer would have done better than some of our recent leaders!

• • •

The other afternoon the educational TV station programmed the new film produced and directed by Dave Bell W6BVN, entitled *The Ham's Wide World*. I was very much impressed with it, and must confess that it turned out a darned sight better than I thought it would. I don't wish to sound patronizing about it, for it needs no qualifying preface or apologetic foreword to prepare the way for some amateurish or unprofessional home-movie type stuff . . . it is a finished product in every sense of the term.

I was a little irked about its limiting the activities shown to those which are ARRL conmected, thus making *non*persons of hams who don't belong to the League. While it is perfectly reasonable for ARRL to depict League activities in any film which it sponsors, it should not be forgotten or overlooked that there are thousands of amateurs, engaged in helpful spheres of hamming, thoroughly in keeping with the spirit of dedication to the public good. This is only a minor point, however, and can be dismissed in view of the overall value of the film.

The best thing about it, to me, is that there are entertainment values in it, which have been all too lacking in its predecessors. Most of the earlier efforts were marred by a certain quality of dreariness. The voice of K4LIB, Arthur Godfrey, is so familiar that any audience can identify with it readily, and he was probably the best possible

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choice as narrator.

You will probably have an opportunity to see the film since it has been accepted by National Educational Television for showing on all educational channels for the next couple of years. I recommend that you take the time to view it, for it is surely an excellent piece of material which should help to promote good relations between amateur radio and the public.

• • •

I've got to level with you about something that's been bothering me since I started writing LEAKY LINES. There have been letters and phone calls ... even visits, all expressing satisfaction and enthusiasm with my position concerning ARRL's extraordinary lack of responsiveness on certain issues recently.

When this sort of response occurs, It is natural to assume that it will be followed by some sort of action. Such a response signifies a readiness to roll up the sleeves and do a job. It denotes agreeement that the League's only chance to become, in fact, what it claims to be, lies in the direction of increased membership activity.

But what have they done? Precisely nothing! That is, all excepting the members of the Atlantic Division, who elected W3EPC, who may just turn out to be the best director in years.

How are the rest of us supposed to match the Atlantic Division? If the only action a member can take is to vote in an election, a lot of people are going to be cooling their heels for a long time. If a member has to suffer the leadership to do anything it wishes, pending the only date on which he can register disapproval, election day, it seems unlikely that anything will be accomplished to effect any improvements. What are we supposed to do until then?

I think the time has come to think realistically about some structural changes in the League machinery. Is it possible, I wonder, to restructure the League, so as to be able to recall or dismiss persons who are not doing, or show no signs of willingness to be doing, the job they were elected to do? In Britain, whenever there is any sort of disagreement in which the opposing forces are unalterably unwilling to come to a position of compromise, they hold a "vote of confidence," in which the popular support and rectitude of the "ins" is tested in a general election. If the Prime Minister cannot muster support for his program, the other party takes over the reins of government, and names a new cabinet. In this way, although the parties may face periodic crises, the body politic is constantly able to renew and refresh itself, secure in the knowledge that the will of the constituency is being served and gratified.

Perhaps we could establish some similar organizational arrangement in the American Radio Relay League. It would certainly be a distinct novelty to know that the democratic (small d) institution of a two-party system, which works so well for our nation, would guarantee a more equitable situation in the ARRL.

Doubtless, this type of change would result in one thing, at least. It would compel every functionary desirous of retaining his post to pay some heed to the membership, lest he get "dumped." If they did not like what he was doing, they would simply hold an election, and the guy would either shape up or ship out.

I've always admired the British. The main reason, I think, is because of this extraordinary tremendous concept of government, geared and gaited for the benefit of the governed, rather than those who govern. Good system, that.

Till next time, 73
... K2AGZ

LETTERS

Leaky Lines Feedback

In regard to the Leaky Lines editorial, I found it one of the most fascinating ham radio articles that I have ever read. I saw thru that bunch of ARRL clowns way back in the 50's. I sure go along with your ideas that the commission believes the ARRL is a spokesman for all of us hams, and I fully intend to tell them that I for one am not a fond member of the ARRL; further, I know hundreds of others who feel the same way.

Kenneth Mahoney K6OPG
455 41st Ave.
San Francisco CA 94121

I think that Dave Mann's ideas are very close to the truth...but I sometimes wonder if the mass of your readers are as fully committed to amateur radio. What I'm trying to say is that I feel that your articles and critiques are causing people to think, and most people don't like to think! If I'm wrong, please correct me.

Neil Johnson W2OLU

With reference to Dave Mann's "editorial" (73, February 1970) about QRM from W1AW, I would like to point out to your readers one example of the faulty reasoning found so often in your magazine. It is true that W1AW is just an amateur station, but unlike any other club station, it represents nearly 100,000 amateurs, worldwide. As such, it has special permission to operate transmitters on seven bands concurrently. As it would be impossible to check all frequencies just before transmitting–and we know that such checks are not always accurate, anyway– I would suggest that Mr. Mann's two friends should step aside graciously in the interests of the thousands.

Al Taylor WB4CTY
5722 1st St. S
Arlington VA

I have just received and read most of February 1970 issue. As I have received and read the first issue and all issues since, I must agree the Feb 1970 issue is one of the greaters. There are numerous articles in this issue and I am glad to see that not only both sides, but most sides are represented.

I must take issue with your Leaky Lines editorial by Dave Mann. It is such articles that have brought much of the things we are not proud of in ham radio today. He says that most all technicians got their licenses by fraud. Who is responsible for this, if true? Certainly not the Tech. Why not call all of the Generals or higher in that give these tests and ask them if the Tech. has a valid license, that they signed their names under oath.

It is a sorry thing that many advanced persons today hate to see anyone less gifted get anything or anywhere. I know of many hams that would rather see a piece of Novice equipment that had gathered dust for years remain so than to help some poor kid trying to get on the Novice band and give him something that will otherwise never be used.

Harold D. Mohr K8ZHZ
5670 Taylor Road
Gahanna OH

I find that Leaky Lines stuff on said-to-be-taboo topics not very interesting in a ham magazine. I am interested in the subjects all right, but not in a magazine that I regard as a technical gold mine. Speaking for myself, I have never hesitated to discuss anything over the air, and have found plenty of other hams ready to take part.

Bob Eldridge VE7BS
8386 McGregor Avenue
Burnaby 1, B. C.

Drumodulation?

Enjoyed the January 1970 issue immensely, especially the article on SSB, AM–FM Modulator by Bill Hayes. Seems though that this article should have been in the April issue. Would like to suggest another method to obtain the same results without using an oil drum. First, the trunk lid should be properly grounded to the car body. Silver-plated finger stock should be fine for this job. Next mount a 10 in. piece of heating duct to the bottom of the trunk. The cavity could then be tuned by banging on the trunk lid with a sledgehammer.

Wallace WA8OXR
5696 Williamson Ave.
Dearborn MI

You have got to be kidding! In the "SSB AM–FM Modulation System" article, Jan 70, F9 is not kosher for ham use.

What he has got there is most probably F9– depending on how he modulates the subcarrin, either AM–FM or FM–FM as in telemetry and all those Muzak-type SCA systems on broadcast FM. Minimum bandwidth of the signal must be in the subcarrin frequencies; in this case 35 kHz deviation, plus bandwidth of the Subcarrier modulation. Not such a good idea except for the wide-open spaces of two or up. Howsomever, the article rates a nod for the idea on cavities. The idea of trying a 55 gal drum hadn't struck me–trying for a low cost Magic Tee for a one-antenna 2 meter FM repeater. A drum might work!

Fritz Hervey WB4MSJ
Rt. 1 Indian Trial NC

Comparison

I received my issue of 73 which was excellent as always. I also picked up a copy of CQ at the newstand and this is what I noticed.

Number of articles in 73: 28 technical articles not counting the excellent editorials.

Number of articles in CQ: 9 and these were not all technical articles. Strange thing too about these 9 articles: 5 were by the same two authors, giving me the impression that CQ is hard up for suitable articles and good authors. This is bad enough but the editorials in CQ are all noncommittal and don't state a positive point. CQ is just

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wishy-washy in its content and will not take a stand where there might be a chance of getting caught in a corner.

Keep up the good work at 73—you put to shame all the other ham publications put together. Even though I am thousands of miles away, you have my support in any way possible.

Richard J. Molby
579th Ordnance Co.
APO New York

Ham Lobby

You undoubtedly saw the article (on spectrum grabbing) in the December 5th Wall Street Journal. This publicity certainly points up dramatically the need for a PR bureau and lobby for radio amateurs.

Everett T. Plumer Wb6VVT
1244 Sixth Street
Santa Monica CA

The article, "Spectrum Scramble — Airwave Jam Worsens As More Radio Users Demand Frequencies" backed up the editorials that I have been writing about the vital importance of our having a lobby in Washington, yet the ear in Newington seems to be as deaf as ever, and nothing else much seems to be taking shape. . . . Wayne

1984

Being relatively a newcomer to the ranks of radio amateur hamdom, having obtained my license only a year ago, I have carefully studied the situation which exists in the amateur world before plunging in with both feet. Years ago while yet in high-school, I had sensed something in regards to the ARRL which at that time I could not quite ascertain the nature of. In your battle against the undemocratic nature and scope of this organization, I believe I have been able to pinpoint the factor which gave rise to a "queasy" feeling earlier and remains with me to this day whenever confronted with this organization. In its manner of operation it resembles some of the radio societies in the Red fascist countries. It seems to serve the interests of "Big Brother" far more actively than the rights of the ham. But the, why shouldn't it *if it was set up by Big Brother* for the sole purpose of keeping control of radio enthusiasts? Instead of trying to instill democratic concepts into an organization which because of its nature can only reject them, would it not be far wiser to organize a new ham organization along the lines of the NRA, AOPA etc? Any new movement though, established while a prior despotic group is still in power, must have as a focusing point a published medium which breathes life and spirit into the soul of the new organization.

Jesse G. Korchmaros WB8CDP
331 Jackson Drive
Campbell OH

Tailored Callsign

When I write to you, it is primarily to announce the event of the year! I've got my call sign, at last.

I got it on my birthday, and it reads LA8PM. Since my name is Per Marienborg, I thought it pretty nice of Televerket (Norwegian FCC).

After having spent my two months summer holiday working, I bought a Sommerkamp FT250 transceiver for about $350. And a Mosley H-band vertical. In addition, I have a W3Dzz multi-dipole for 80 and 40.

Now, I am QRU on 10 meters almost every day. I may be identified by overmodulation, and the fact that I say Ah..., each third word and Well...about every seventh. I suffer from mike fright.

Per Marienborg LA8PM
Stovnervn. 17
Hoybraten Norway

Helping Hand

The STI Amateur Radio Club (WB9ADF) has undertaken a "Helping Hand" project to assist hams or would-be hams in solving their technical problems. We wish to extend this service to hams in all parts of the world, and particularly to those who are just getting started in ham radio or who are isolated from help. As a technical pool from which to draw solutions, the members are students working toward the Associate Degree in Electronic Engineering Technology, and are hams themselves for the most part, with a highly trained staff of instructors to back them up.

If you feel this project is of a worthy nature, we would appreciate it if you would mention it in a future issue. Inquiries and problems should be addressed to: STI Amateur Radio Club, Sams Technical Institute, Interstate Industrial Park, Fort Wayne, IN 46808.

Jeffrey Stineburg WA9TOJ
Trustee, STI Amateur Radio Club
WB9ADF

Why?

Why is it that...the only audible station on the entire 20 meter band has an operator who speaks only Esperanto and I have no way in God's world of making contact...the only 9M6 I ever heard was when the XYL gave me the supper ultimatum on the double...the one maritime mobile I really wanted came back to me when my swr bridge took a turn for the worse...the most important phone patch I ever tried was lost in band transition...the one opportunity to impress a VIP resulted in a "no propagation" day...the one last country I have looked for to make 200 was heard by the XYL while I was at work and I have been listening for 2 years while she has just learned how to tune the rig...the one piece of gear I ever bought through advertising was damaged before I got it...the QSLs were sent with an apology for being the wrong color...the YL with the most pleasing voice turned out to be an XYL...the day I was about to trade in my rig was the day I had the best contacts...my neighbor who complained about my interference admitted that his hi-fi broke down and then, when he had it repaired, he complained that he could *not* hear me: I have had no interruptions from my neighbors ever since I explained that my large antenna (beam) was for color TV...that the pink slips were an attempt to work WAFCC stations...I had failed to achieve this very simple goal.

Ian M. MacDonald DL4MI
KARLSRUHE
W. Germany

Author Talkback

This letter is in reference to my article (published in the July '69 issue) "A Simple Effective RTTY Terminal Unit." In this article it was not made clear as to the counting of the pins of the integrated circuits involved. Since I have received so many letters and phone calls from readers who can't make the unit work, and the problem, with only one exception, has been the integrated circuits in the circuit wrong, I would like to point out the correct basing diagrams.

On the μA 710C, the tab is over pin 8 and looking at the bottom view, the pins are counted clockwise in ascending order. On the MC1429G, the pins are counted in the same manner, *except* that the tab is over pin 1.

As I mentioned, I have heard from quite a few readers who have had minor problems, now I would like to hear from a few who are using the circuit.

C. Warren Andreasen WA6JMM
3737 King St.
Lemon Grove CA

RG-8 Dummy Load

"Lossy Transmission Lines" by KH6IJ/1 (Feb 70) rang a bell with me: somewhere in the pile of junque I moved down here to the land of warm (?) winters, white likker, and some of the best looking women in the wide world is a hunk of RG-8/U labeled "Federal" which has a grey-ish looking dielectric rather than the usual translucent sort. About 60 feet long, this has long been my "Don't buy surplus line" convincer. Terminated w/50 ohms, fed by any 2 mtr xmttr thru a Bird Thruline will show, say 10 watts in, NO refl pwr. Move the Bird down to t'other end, feed in same 10 watts, *NOTHING OUT!!!* Repeat Experiment with two Birds, same results. Lossy? You bet! Loss showed up above about 20 MHz, negligible, lower. Experienced same thing with new 7/8" foam line, solid OD: 42 MHz loss 100% Found water in the foam!

Fritz Hervey WB4MSJ
Box 25006
Charlotte NC

New Church

Now that the impact of this incentive license business is being felt by the majority of radio amateurs, many of us are becoming dismayed by conditions on the portion of the bands we are forced to use. Even some of the old timers have given up amateur radio as a hobby.

I can't see any hope that The Organization will ever do anything for us. Yet they have so many advantages ever over any of the other three amateur publications: They alone have the amateur's bible and sunday school pamphlets; they are the umpires of all the games (contests); they set up the rules on how the games are played. There are no other referees.

As I see it, we need a new church, a new ritual, and above all a new bunch of deacons. Perhaps then we can get back that which was taken from us.

John McFarland
Port Richey FLA

Candid Suggestion

As editor/publisher, you will of course be responsible for everything in your mag, and quite probably a lot not in it. Perhaps you could perforate the page with your comments and the people not liking same can detach and file, while enjoying the rest?

Michael R. Hanna K8UUO

W. B. Cameron WA4UZM
324 Riverhills Drive
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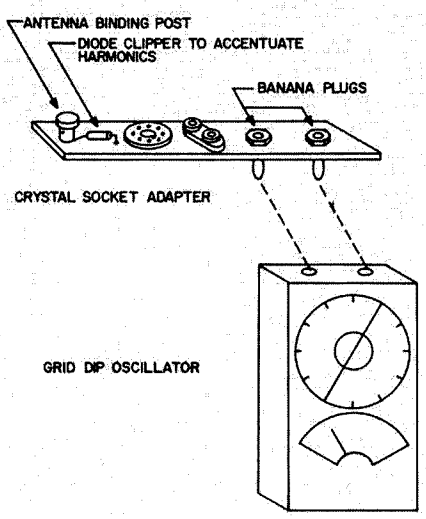
A plug-in adapter turns the oscillator into an A1 crystal calibrator . . .

One of the handiest instruments around the average ham shack is the grid dip oscillator, but many hams do not get all of the advantages this little instrument can offer. Most people know that it is useful for finding the resonant frequency of an LC circuit, or for generating a signal someplace in the range, although it is not quite a substitute for a well calibrated signal generator in this respect.

Many people do not realize that the grid dip oscillator makes an excellent crystal

calibrator as well. The typical grid dip oscillator uses a two-terminal coil and a two-section variable capacitor, connected in the form of a Colpitts oscillator circuit, with the variable capacitor providing the voltage division for proper feedback. This same circuit, with a quartz crystal replacing the coil, becomes a very satisfactory crystal oscillator. In this case, the variable capacitor becomes a trimming capacitor capable of putting the crystal on the proper frequency with considerable accuracy and also allowing a fairly wide latitude higher or lower for checking bandpass.

The meter reading gives an index of crystal activity. What is required is an adapter to match the pins of the crystal holders to the coil socket of the grid dip oscillator. I have made up such an adapter for my particular unit which consists of a 1½



Crystal socket adapter for grid dip oscillator extends the unit's capability by enabling it to read crystal activity.

inch by 4½ inch piece of masonite which carries two banana plugs to insert into the oscillator socket, and several different sizes of crystal holders, all connected in parallel, to accommodate any crystals I happen to have around the shack. I carry in my tool kit various assorted crystals. These give me spot frequencies for band edges and other reference points on all of the amateur bands.

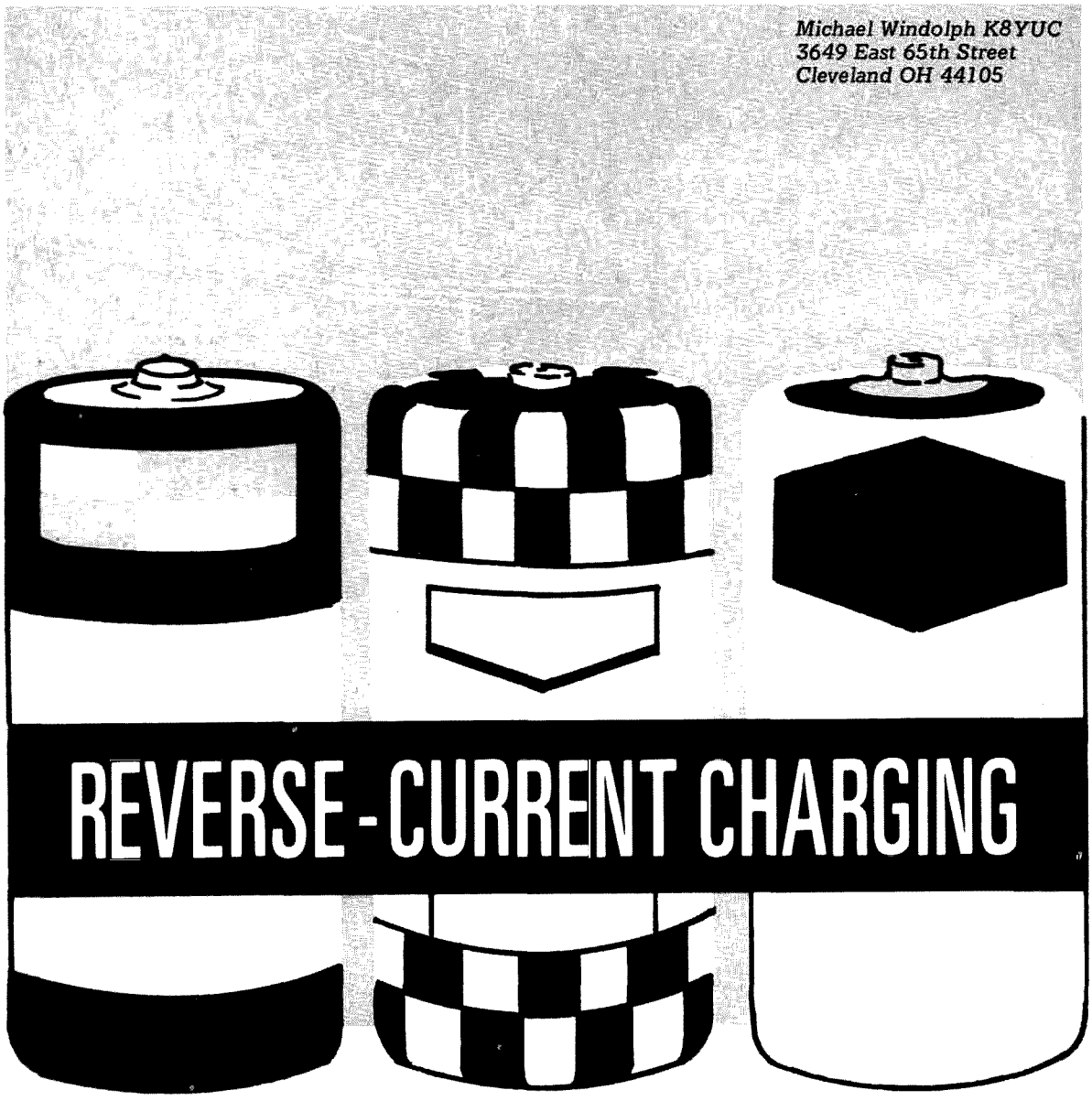
In checking the higher frequency bands, I find it useful to add a diode clipper and have one permanently wired on the same adapter board. This is a 1N69 which simply goes from one side of the crystal to a terminal point at which I can attach an antenna or a lead to the input jack of the receiver. By simply attaching a short length of wire approximating a quarter wavelength at this frequency, I can provide a strong enough signal from the shack to enable me to check out my direction finding loop in the automobile fifty feet away.

In tuning up my 2 meter FM gear, I plug in a 3061.25 crystal (which is the transmitter oscillator crystal for my Link 2m FM unit) and then couple from the 1N69 to the input of the receiver. This provides a signal stronger than most of the local signals on the band, and adequate for initial tune-up. For finer adjustment of the i-f strip, I clip the lead from the 1N69 to the chassis close to the antenna input jack and the leakage provides a signal of the order of .2 μV, which is useful for final adjustment of the critical tuned circuits, the squelch control, and others. For best results, I leave the oscillator and the receiver on for a half hour or so to warm up, and then with the variable capacitor in the grid dip oscillator, I zero-beat the incoming signal of a station generally considered to be on frequency. Once this is done, I have a signal source on the bench with which to check the receiver for passband balance as indicated on the microammeter connected to the discriminator output.

One thing which could be added to increase the utility of the instrument is some form of modulation. It would not be too hard to add an outboard modulator connected to the oscillator through pin jacks or some other means. I have not done so simply because I happen to have a modulated signal generator in the shack.

. . . WA4UZM ■

Michael Windolph K8YUC
3649 East 65th Street
Cleveland OH 44105



REVERSE-CURRENT CHARGING

With an almost foolishly simple technique you can successfully recharge ordinary dry cells — and make them hold the charge — again and again!

Do your kids continually pester you with their battery-operated toys that don't work any more because the batteries are dead? Or do you use a flashlight or other battery-operated gadget often enough yourself that you wish you could afford rechargeable cells? Maybe this article can provide the necessary relief without any extra strain on your pocketbook.

Would you believe you could make a better battery charger? How about one that can charge at twice the usual rate or more, without damage to the battery? Or one that can charge, *really* charge the ordinary flashlight battery even higher than its bought-new charge?

It can be done! The process was invented in 1954 by Ernst Beer of the Netherlands

and bears patent number 2,752,550. Recently tested by Donald J. Vargo of Lewis Research Center in Cleveland, the process resulted in a better mousetrap – it really did the job better!

Although normal flashlight batteries will give, in a lifetime, about 2 or 3 A-hr of current (at 250 mA drain), with this new technique of recharging, some have given 30 to 40 A-hr and are still going strong!

Such claims sound fantastic –but try it before you decide it's impossible. It is quite a simple discovery and one that is not yet fully explained. But it works. Chemists are not really certain of all the chemical changes taking place in the normal battery. Theoretically, the chemical changes taking place when a cell is discharged should be reversed when the cell is charged. But this theory does not take into account an effect called "polarization," which tends to restrain the reaction. Besides, it has been found that with the ordinary dc charging technique the zinc of the regular LeClanche (flashlight) battery does not just migrate back to its proper place. It tends to clump up and form crystals or spikes of zinc on the negative electrode. Then further discharging thins out even more the zinc between clumps and you soon have holes in the zinc. Your cell dries out and you have a dead battery.

The discovery of Mr. Beer was a way to get the zinc to return to the negative electrode in an even layer instead of in clumps. This he accomplished by putting a small reverse current through the cell at the same time he was charging it. No one as yet has figured out just why this works but tests indicate that the reverse current seems to serve as a depolarizer. At any rate, it improves the efficiency of the charge many times.

In electroplating, this technique is used and results in much smoother, hard and even plating. Another effect of this higher efficiency in charging is that one can charge a cell at a much faster or higher rate without the cell heating up. With flashlight cells the only condition is that the cell not be already dead. Nickel–cadmium cells, of course, can be completely discharged and will still accept a charge.

It is best to recharge a carbon–zinc (flashlight) cell before it has dropped below 1.3V. After this point, the cell soon develops holes in the zinc with consequent drying out and deterioration. However, it was found that even a cell with some very small holes could be rejuvenated because the zinc is recoated so as to actually seal up the small holes! A lead–acid cell which would accept no more that a 50% charge by the ordinary technique was built up to a complete charge by alternately charging and discharging with this new circuit until it was up to full capacity.

The circuit is simplicity itself. All that is necessary beyond the diode rectifier and the resistor (or capacitor used as a reactance-type resistor) found in the cheapest recharger, is another resistor across the rectifier. This second resistor allows some ac to flow through the cell and so the technique is called asymmetrical alternating-current charging. It has been found to work best when about 10% of the forward current is allowed to flow backward in the circuit. You can easily calculate the necessary resistance.

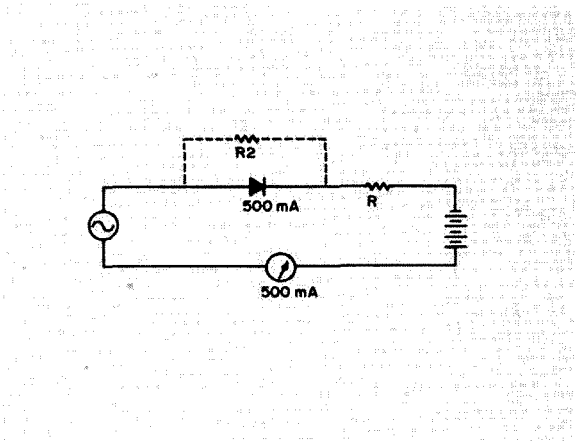


Fig. 1.

First set up your circuit as in Fig. 1. By trial and error figure out the resistance of R. Do this by deciding how much charging current you want; e.g., for a typical nickel–cadmium cell, you might choose the 100 mA they are usually rated for – or about the same or more for an ordinary flashlight cell. Begin by using a high resistance at R. This depends

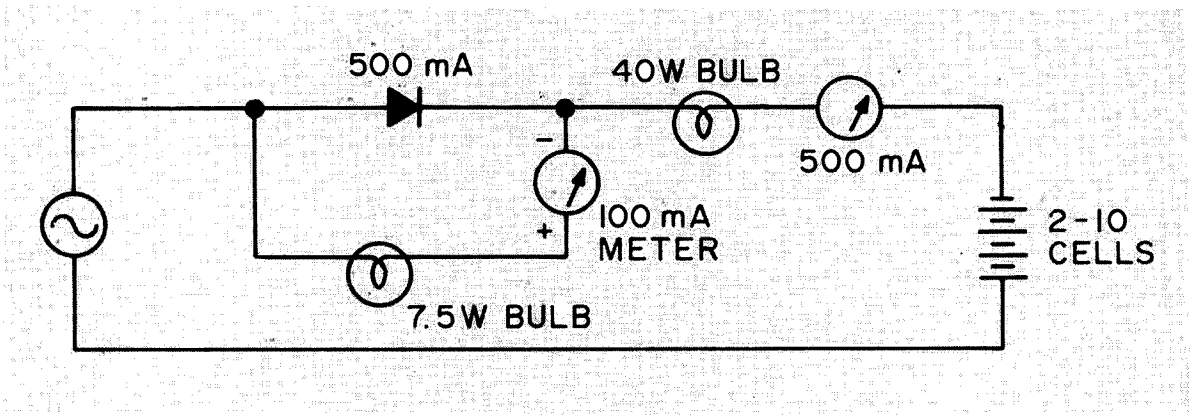


Fig. 2

on your ac source; if you use 117V you could try a 10W light bulb in series, but with only 25V or so from a transformer you could get by with a few thousand ohms to begin with. Then gradually reduce the resistance (or use a higher wattage light bulb) till the meter shows about 100 mA. Remember, the resistance has to be able to carry 100 mA, so use one of adequate rating.

Next, multiply R by 10 and place the corresponding resistor across the rectifier and you're finished. Make it big enough to carry the 10 mA of current it will be drawing in reverse. Or if you like to use trial and error, you can try different resistors at R2 also, starting with one at least 10 times greater than R and reducing it till you get the 10 mA reverse current. Remember, this is *reverse* current, so connect your meter leads accordingly.

As previously stated, this system allows recharging at a much higher rate than ordinary chargers, and without overheating a cell, I recharge my 100 mA nickel–cadmium cells at 275 mA with about 30 mA reverse current flowing. Figure 2 shows the circuit of my complete battery charger using this new technique, along with an added refinement. Due to the 117V source current and the current-dropping light bulbs, this circuit enables one to charge anywhere from 2 to 8 or more cells in series at one time without changing the circuit at all for each cell I add to the circuit This is because the line voltage with only the bulbs in series produces an essentially constant-current source for the rectifier and any number of cells. Actually, by bulb ratings one should use a 4W bulb to go with the 40W bulb, but according to actual current drawn, the 7.5W bulb proved a better match to draw 10% of the forward current.

The meters are not necessary, of course. Once you measure and obtain the current you want, or just use this circuit as is, the meters are no longer needed unless you want to be sure current is being drawn. With this circuit you will draw about 275 mA through from 2 to 8 nickel–cadmium cells. If you use ordinary flashlight cells there will be less current as carbon–zinc cells have more internal resistance than nickel–cadmium cells.

The best way to determine length of charge is to figure the normal capacity of the cell and charge accordingly; a 1 A-hr cell, for example, could be charged at 250 mA for about four or five hours. Cells have been left for days in this charging setup without any apparent damage, so don't be too concerned over a few extra hours.

Another way to check charge is to measure the voltage across the cells. Towards the end of a full charge the voltage will rise. Ordinary flashlight cells, if new, can be charged to almost 2V each. They lose the extra voltage soon afterwards but it is an increase of energy that no common charger will give.

So, dig out all your dying batteries and see which ones are capable of a lot more life.

. . . K8YUC ■

Source: "Brief Investigation of an Asymmetrical Alternating-Current Battery-Charging Technique" by Donald J. Vargo — Technology Utilization Office Lewis Research Center, Cleveland, Ohio.

Donald L. Milbury W6YAN
Box 463
West Covina CA

A Poor Man's Frequency Meter

How to turn a few cheap surplus sows' ears into a satin handbag.

While the FM'ers may be the only hams around who make a religion out of being precisely on frequency, virtually *all* active amateurs have a need for a frequency meter periodically. Well, this may come as something of a shock to some, but there *is* a way to measure frequency accurately without the use of expensive equipment. With a handful of parts and a few items found commonly around the radio shop, you can build the *poor man's frequency meter*, which is capable of tolerances that should amaze you.

This is *not* a substitute for a good frequency meter for commercial use, but if you have a limited number of frequencies that you want to be "dead on," this may be the answer. And it ought to be a must for the group of fellows who maintain the local FM repeater.

A nice feature of the *poor man's frequency meter* is the fact that it puts to use that old surplus military communications receiver which has undoubtedly been sitting around in a dark corner of your basement under piles of old magazines and discarded dynamotors. It also uses any old commonly available surplus wideband FM receiver, such as the types advertised in this issue of 73.

The idea is not new; hams in the two-way business will recognize it as the system that has been used for many years for the Motorola station monitor and various other common applications. Basically, it is composed of four major units:

- Receiver converter with calibration oscillator constructed on a high-band front-end deck from an old Motorola Sensicon A receiver chassis.
- Monitor receiver (any 150 MHz wideband receiver); a low i-f of 455 kHz is best.
- WWV receiver (here is where the surplus communications receiver comes in).
- Accessory items (hang a modulation meter on it).

The block diagram of Fig. 1 shows how the individual items of equipment are interconnected to form the frequency meter. Note that although a narrowband receiver can be used, a more dependable "off frequency" indication is obtainable with a wideband i-f receiver. Periodic calibration (before use) to WWV is recommended for high accuracy measurements; however, the unit will maintain its operating frequency to within 1 kHz (an error of 0.0006%) for an ambient temperature within the range of −20°C to +60°C.

Principle of Operation

The frequency converter operates on the heterodyne principle. A station frequency is

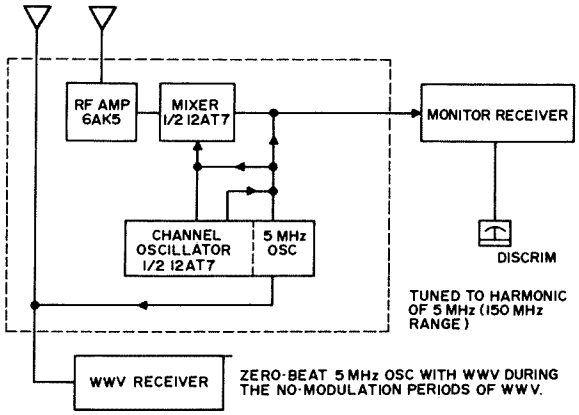


Fig. 1. This system block diagram shows how equipment should be interconnected to make the frequency meter setup.

monitored by heterodyning its carrier with the output frequency of the crystal oscillator and then feeding the resultant frequency of these two signals into the calibrated monitor receiver. If the beat frequency between the crystal oscillator signal and the monitored carrier is exactly equal to the frequency to which the receiver is aligned, the discriminator meter will indicate zero. If the beat frequency is lower or higher in frequency than the one to which the receiver is aligned, a direct indication of carrier frequency error in the monitored transmitter will be given on the meter.

The monitor receiver is aligned to a predetermined frequency. The specific frequency used will depend upon the spurious harmonics emitted by the channel crystals which will be required to monitor the specific carrier channels in consideration, plus the operating frequency to be measured.

The beat frequency fed to the control receiver may be either the sum or difference frequency of the channel crystal frequency and the monitored carrier frequency. Channel crystals for operation in the range from approximately 1.6 to 12.5 MHz may be used.

Calibration Oscillator

The calibrating oscillator consists basically of an rf amplifier stage, a mixer, and an oscillator. The calibrating crystal, shunted by a trimmer capacitor for any minor adjustment of oscillator frequency, is used for calibrating the monitor receiver.

Although the crystal is temperature controlled, a *greater degree of accuracy is obtainable without the use of the heater.* The trimmer capacitor provides *exact* calibration of the crystal frequency at any temperature by zero-beating the oscillator against the WWV signal.

The crystal heater should be used *only* when a quick check is necessary; such as, where it is desired to quickly bring the crystal to a temperature that would eventually be reached due to the heat dissipation of the equipment.

The control receiver may operate in the 145-160 MHz range; therefore, when using a 5 MHz calibration crystal, the 29th, 30th, 31st, or 32nd harmonic of the 5 MHz crystal

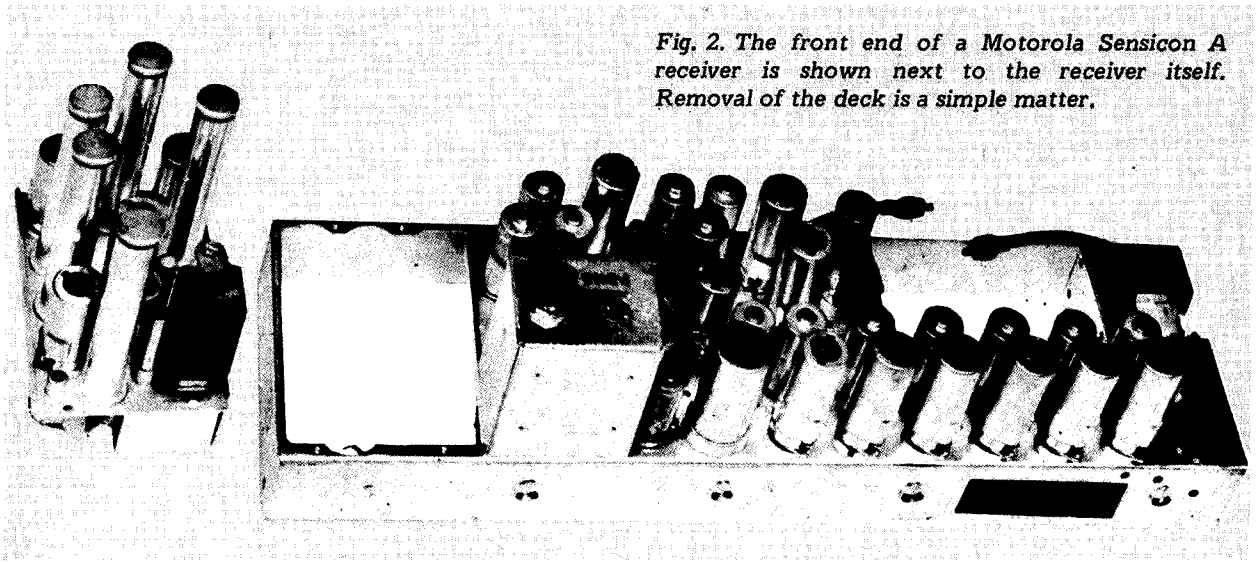


Fig. 2. The front end of a Motorola Sensicon A receiver is shown next to the receiver itself. Removal of the deck is a simple matter.

frequency is used to calibrate the receiver to 145, 150, 155, or 160 MHz.

The selector switch operates in conjunction with the calibrating oscillator. This switch may be used to select any one of several crystals as the frequency controlling element of the oscillator. These crystals include the 5 MHz calibration crystal and the five channel crystals.

One half of a 12AT7 tube is used as the oscillator while the other half of the tube functions as the mixer. The carrier frequency to be monitored is picked up by the VHF antenna, amplified by the 6AK5 amplifier, and then mixed with the selected channel crystal frequency. The output of the mixer is fed to the calibrated monitor receiver where it is determined if the transmitted carrier is on frequency.

Assume that it is desired to monitor the output of the transmitter which is operating on 146.94 MHz and that the control receiver has been calibrated at 150 MHz. The necessary channel crystal frequency will be the difference between 146.94 MHz and 150 MHz, or 3.06 MHz. If the transmitter is on frequency, the 146.94 MHz signal will mix with the 3.06 MHz channel crystal frequency to produce an input signal of 150 MHz at the control receiver. In this case, no indication will be given by the discriminator meter. If the monitored transmitter carrier is above or below its designated frequency, the input signal to the monitor receiver will be above or below 150 MHz, causing the discriminator to produce an output voltage. This voltage is fed to the meter, which is calibrated in kilohertz to give a direct reading of carrier frequency error.

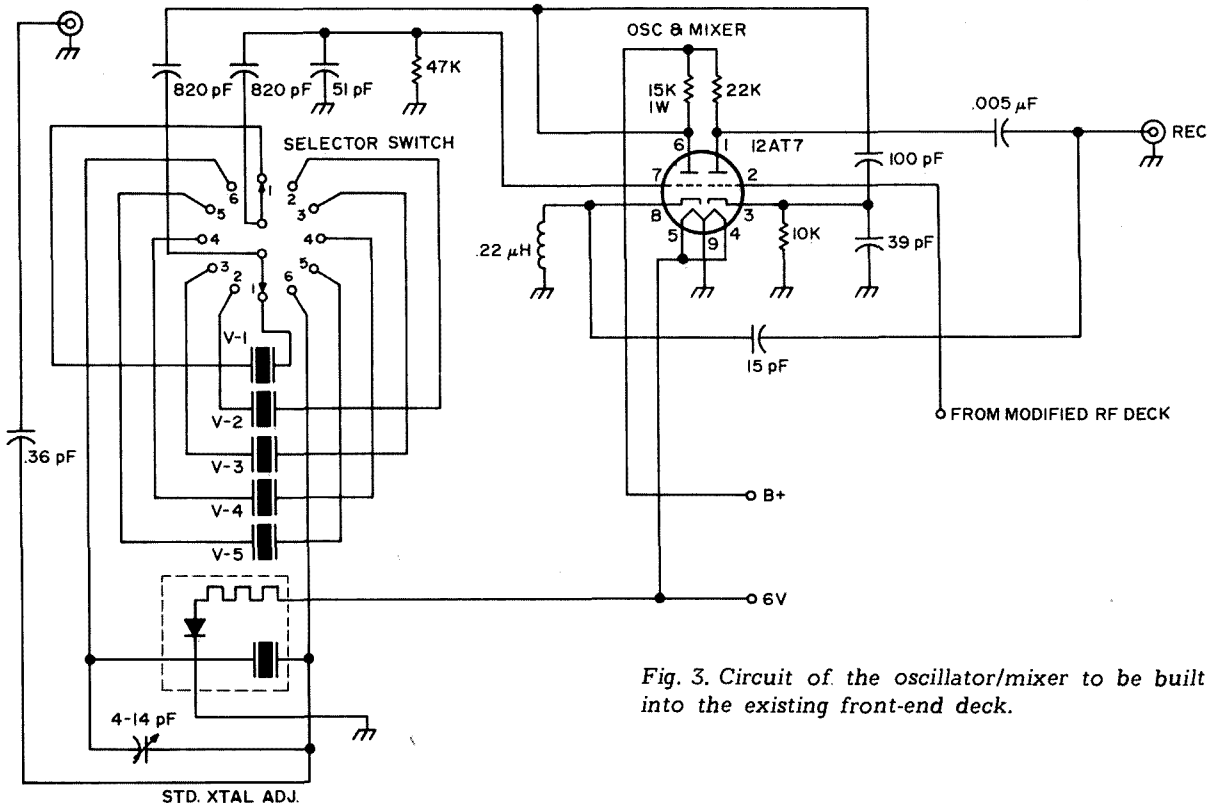


Fig. 3. Circuit of the oscillator/mixer to be built into the existing front-end deck.

When monitoring transmitters which operate in the 420–450 MHz band, the monitor must be placed so that the monitor antenna is within a few feet of the transmitter. For this application, the frequency of the stage preceding the final tripler is monitored. This is done by selecting a difference frequency crystal for the monitor which, when beat against the frequency of the transmitter stage preceding the tripler, produces the frequency at which the control receiver is tuned.

Say that it is desired to monitor the output of a transmitter operating on 443.75 and that the monitor receiver is calibrated at 150 MHz. The channel crystal frequency is determined as follows:

443.70 ÷ 3 (tripler) = 147.90
(frequency actually monitored)
150 – 147.90 = 2.1 MHz
(channel frequency crystal)

If the transmitter is on frequency, the frequency of the stage preceding the final tripler will mix with the 2.1 MHz channel crystal frequency to produce an input signal of 150 MHz at the monitor receiver. In this case, no indication will be given by the discriminator meter. If the monitored transmitter carrier is above or below its designated frequency, the input signal to the monitor receiver will be above or below 150 MHz, causing the discriminator to produce a positive or negative output voltage. This voltage is fed to the discriminator meter *which can be calibrated to give a direct reading of carrier frequency error.*

Any error in carrier frequency indicated on the discriminator meter is an error in the frequency of the stage preceding the tripler; therefore, the error in the transmitter signal from the final amplifier will be three times as great. When using this method of monitoring, check the output (420–450) of the transmitter with a reliable wavemeter to ascertain that proper frequency multiplication is made.

Channel Crystal Accuracy

Since the fundamental frequency of the channel crystals is used, any error in crystal frequency is not multiplied. Therefore, the error in monitoring a frequency by this method is very small. Crystals are held to within 0.002% of the specified frequency over the ambient temperature range of –30°C to +60°C. Therefore, with the previous 2 meter example, the maximum frequency error of the 3.06 MHz crystal would be 3.06 x 0.0020%. At the frequency being monitored, the percentage error would not be discernible on the meter.

The "improvement factor" of possible percentage accuracy at the channel crystal frequency over the percentage accuracy at the carrier frequency is approximately the same ratio as the monitored carrier frequency over the channel crystal frequency, or 146.94/3.06 equals 48. This is another way of stating that the channel crystal is more than 48 times as good percentage-wise at the monitored frequency than at its fundamental frequency.

The improvement factor may be checked on any channel by the above method. It will always remain reasonably high; therefore, the possible error of the channel crystal frequency is negligible.

The front end deck of a Motorola Sensicon A receiver provides an ideal converter for the *poor man's frequency meter.* Figure 2 shows this assembly as a separate unit as well as in its original form installed in a Motorola Sensicon A receiver. The part numbers referred to in the modification procedures described here are those part numbers called out in the Motorola manual for the Sensicon A 150 MHz receiver. The procedure is quite simple, too. Here is all you do:

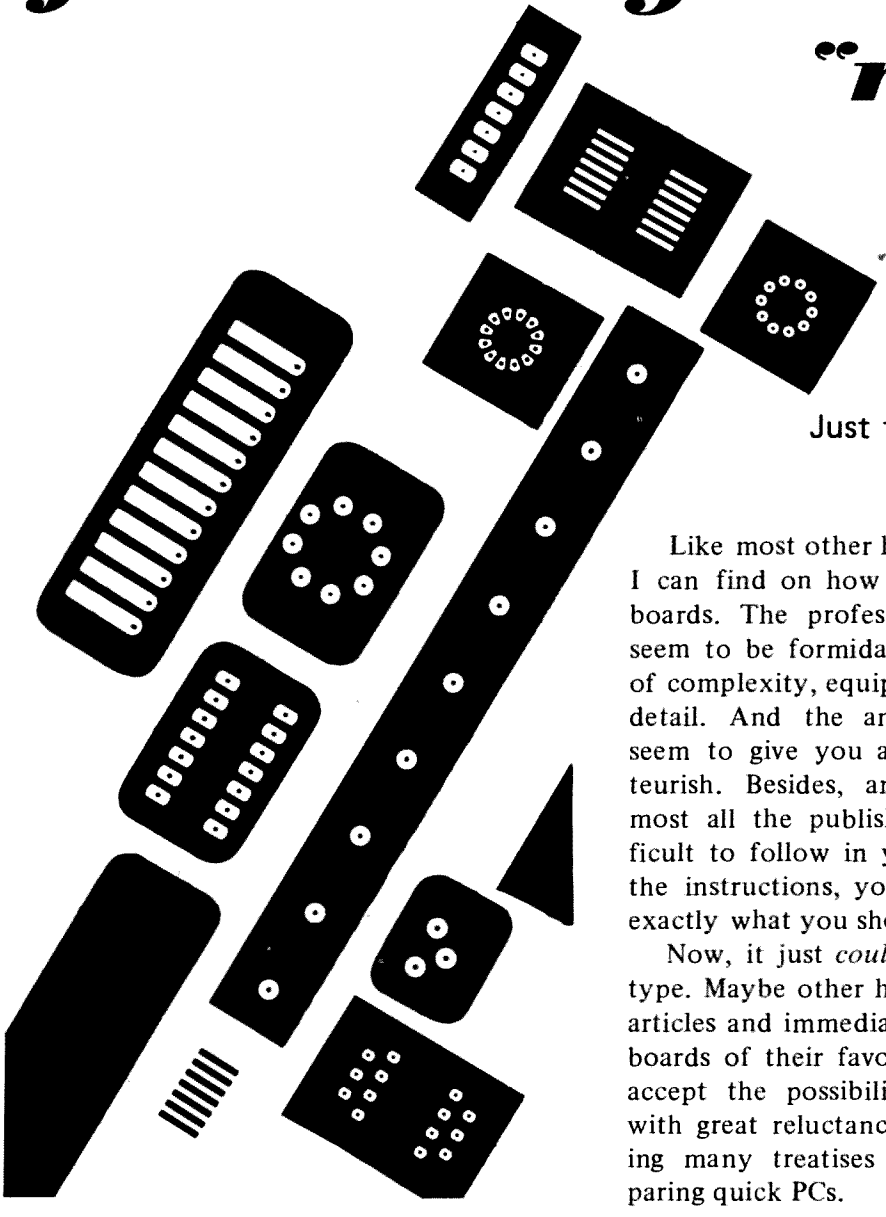
1. Replace R102 (2.2MΩ) with 3.3 MΩ and ground low side.
2. Remove C104.
3. Replace R103 (33 kΩ) with (470 kΩ).
4. Replace L101 with a 100 kΩ resistor.
5. Remove R112 (3.9 kΩ), complete B+ circuit.
6. Replace X102 with 9-pin socket (with shield).
7. Remove wire from pin 1 and connect to pin 2.
8. Connect 1 MΩ resistor from pin 2 to ground.
9. Wire 12AT7 socket for 6V filaments. (Connect 6V to pins 4 and 5, and ground pin 9.)

This completes the modification of the rf amplifier. To construct the oscillator/mixer, remove the balance of the circuitry on the deck with the exception of the crystal socket. Then build the circuit as shown in Fig. 3 around the new X102. Be sure to use silver mica capacitors in the crystal circuits. The crystals themselves are Motorola SFMT-2 (R11, 5 MHz), and they may be obtained from Sentry or International.

The Sensicon A receiver is found in a number of the older, less expensive Motorola FM units, such as the 40V, the early 41V, and all Model series bearing the AAV and AAD suffix. These are available from Newsome (Detroit), Mann (Tarzana, Calif.), C & H (Long Beach, Calif.), and Gregory (Saddlebrook, N.J.). . . . W6YAN■

Ken Sessions K6MVH/1
RFD 2
Peterborough NH 03458

Professional PCs from roll-your-own "negs"

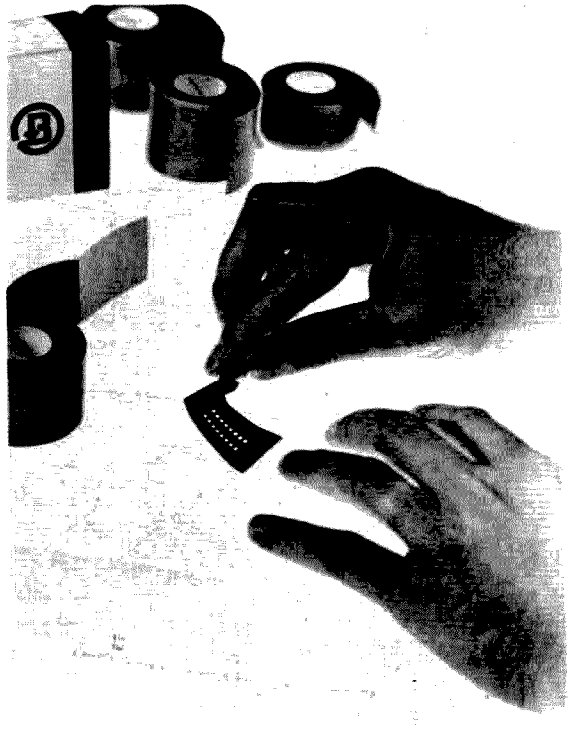


Just the thing for the next club project!

Like most other hams, I read every article I can find on how to make printed-circuit boards. The professional processes always seem to be formidable from the standpoint of complexity, equipment requirements, and detail. And the amateur methods always seem to give you a board that *looks* amateurish. Besides, amateur or professional, most all the published procedures are difficult to follow in your mind; as you read the instructions, you find it hard to know exactly what you should be doing and when.

Now, it just *could* be that I'm the dense type. Maybe other hams breeze through the articles and immediately whip up five or six boards of their favorite circuits. I began to accept the possibility of my "numbness" with great reluctance and only after digesting many treatises on the subject of preparing quick PCs.

Then one day, while I was preparing a batch of "new product" announcements for a trade magazine in Chicago, I happened across a news release from Sol Shein Advertising Agency that extolled the virtues of a simplified PC production process developed by Bishop Graphics, Inc., a California firm. The text supplied rapidly lost me as had all the previous articles I'd read, but the cagy



Step 1. Negative (B-Neg) version of a typical dual in-line IC package is laid down just the way positive configurations are handled.

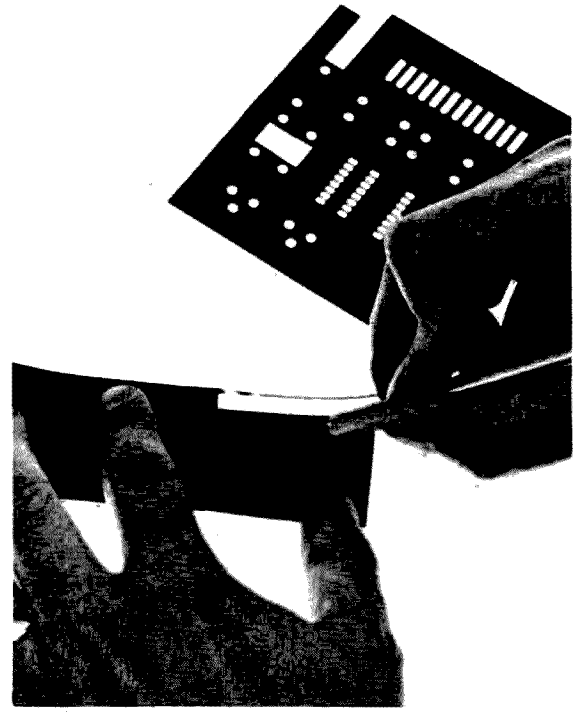
people at Shein were clever enough to foresee possible confusion, so they included a raft of photos that showed the complete preparation process, from layout to finished board.

I made a mental note at the time to write an article for 73 Magazine at my earliest opportunity; 73 readers, I reasoned, would appreciate as much as I do a truly easy way to make their own professional PC boards. The "mental notes" proved to be ill-filed, however, because I lost them as well as all of the photos when I moved from the Chicago area to Peterborough. But – as luck would have it – the Shein agency was on the ball; their press releases were also sent to 73, photos and all.

The Bishop Process

The Bishop Graphics company produces a photoresist solution that can be used to sensitize a copper-clad board for photo exposure. The product line also includes developer, etchant, and stripper; but the big thing is the technique they have for eliminating any drafting, camera work, or the necessity for darkroom processing.

The Bishop method involves the use of preprinted "negatives" which can be placed in any configuration to suit the needs of the individual. The negative patterns – including transistor layouts, dual in-line IC patterns, and a thousand and one other variations – come already printed on pressure-sensitive "B-Neg" acetate. The company also



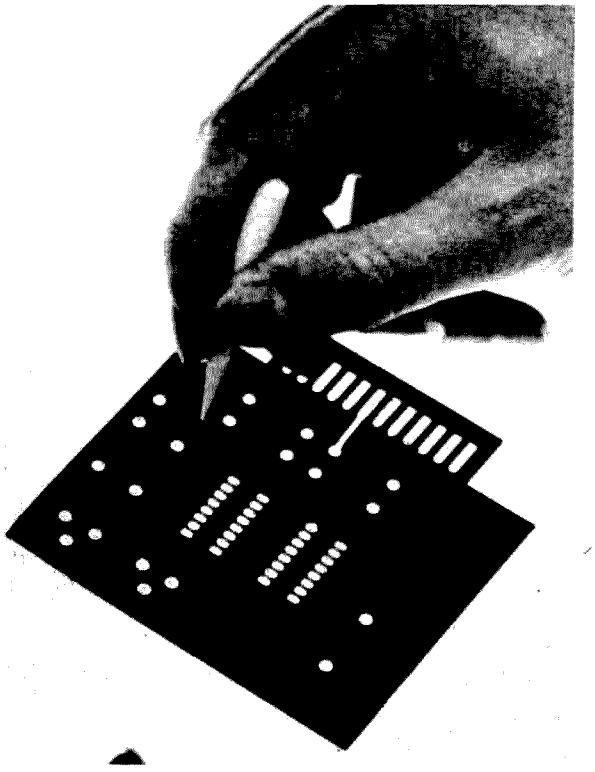
Step 2. Opaque black B-Neg "background" film fills in spaces between terminals.

supplies pure black pressure-sensitive B-Neg material so that anyone can form his own completely custom-designed negatives.

The completed B-Neg pattern can be used to produce a positive pattern on the presensitized (photoresist) copper-clad laminate or film. And the laminate, quickly etched on the spot, becomes a circuit board ready for drilling and component wiring. The whole

process takes an hour or two –and the result is a *professional* job.

The steps are simple. After the B-Neg pattern is laid down on a thin transparent Mylar, acetate, or film base, the clear areas are overlaid with a mask of B-Neg opaque film. Then, with a sharpened piece of white chalk or any light marker, interconnecting circuit lines are drawn on the B-Neg mask to establish conductor paths. Corrections of



Step 3. Circuit lines are traced in white chalk or marking pencil.

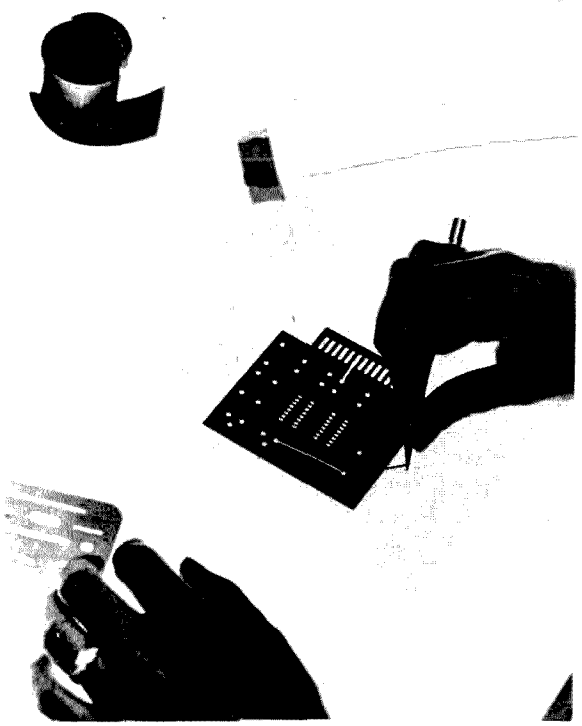
mistakes or changes are easy. Simply rub away the chalk and redraw the conductors.

The final conductor paths are established by cutting along the established chalk lines and peeling away the B-Neg material. Fine conductors may be scribed. Conductor paths can just as easily be eliminated by covering with the black B-Neg mask material.

The completed B-Neg and copper-clad laminate (which has been coated with Bishop photoresist) are placed in a contact frame or in a plate glass "sandwich." Exposure under an ultraviolet light source (or a noontime summer sun) takes no more than a few minutes, and the subsequent developing, etching and strip/rinse cycles can be completed in approximately an hour. The board is then ready for drilling and assembly.

If you are accustomed to producing your negatives with a regular process camera, you should know that existing negatives can also be changed quickly with B-Neg. Entire patterns can be relocated or conductor traces changed without retaping and reshooting original artwork.

All B-Neg pads and patterns are available in 1:1 scale. Other necessary materials are available from Bishop dealers: Mylar matte base material and grids, knife, tweezers, erasing shields (for cutting accurate conductor paths), and white charcoal pencils. If you don't know where to get Bishop's B-Neg stuff, write to the main office at 7300



Step 4. Using common eraser shield for a guide, neat circuit paths are cut and peeled.

Radford Ave., No. Hollywood, Calif. 91605. Chances are you'll even get a free sample.

Getting the Material Together

There are several ways you can go when you get on a PC production kick. You can do it the easy way by sending $28.50 to Bishop Graphics, which gets you a complete PC production kit, including an exposure frame and a couple of processing trays. Or you can scrounge and cumshaw and do

everything kind of slipshod the way I do. My system differs a bit from Bishop's recommended procedure, because I am inherently cheap; as a consequence, I don't employ the trays and contact frames and other trinkets and niceties the Bishop brochures rave about. But my method is just about as effective, even if a bit more cumbersome . . . and after all, it *is* my story.

The table presented here shows the material recommended by Bishop alongside the material I recommend for the cheapskate scroungers. With care, you should get excellent results regardless of which bill of materials you use.



Step 5. Finished B-Neg and photoresist-coated copper-clad laminate are placed in contact frame.

Bill of Materials

Bishop Catalog number, description, and price.			Scroungers list and price
	B-Neg material and patterns as necessary		Same as at left
7902	Photoresist, 7 oz. aerosol spray	$6.85	6.85 Same as at left
7904	Developer	1.50	1.50 Same as at left
7905	Stripper	1.25	1.25 Same as at left
7906	Tray set	1.25	2 shallow pans—one metal, one ceramic, plastic, or paper.
7908	Etchant	5.80	5.80 Same as at left
7909	Contact pressure frame	7.55	2.98 8 x 10" picture frame w/glass and backing
7952	4 x 6" boards (1 side copper)	4.50	4.50 Same as at left
	Ultraviolet fluorescent lamp	29.95	Free Sunlight
		$56.65	21.88

Preparing the Board

Prepare the copper-clad laminate *carefully*. All soil, stains, and foreign matter must be completely removed. Scrub it with ordinary household cleanser and a stiff brush. Rinse. Repeat the scrubbing. Rinse again. Wipe off thoroughly with a clean towel. Rinse *again*. Now air-dry (or oven-dry at 110° to 120°F), always handling with care and never touching the surface with bare hands or fingers. (Residual oils in the skin will reduce the quality of the end result.)

If you don't have a darkroom, wait until after dark before you prepare the board. In the dimmest light possible, place the clean, copper-clad laminate on a protective background (several paper towels) and spray on a full, even coat of Bishop photoresist, following the directions on the can. Immediately pick up the board and slant one edge toward the floor. As the 'resist runs to the lower edge and forms a bead, soak the bead off with a paper towel. Turn the board 90° and repeat (the equivalent of a slow spinning action) so that excess 'resist is removed and no longer forms droplets at the lower edge. Then place the board flat for air-drying (or in an oven at 110° to 120°F). The 'resist will flow out, leaving a very even layer. For further processing, the board must be completely dry . . . no tackiness, no solvent smell.

With the B-Neg protomaster and a contact frame close at hand, half-fill a shallow metal or ceramic dish or tray. (Don't use plastic or you'll find yourself with no dish and a big mess.)

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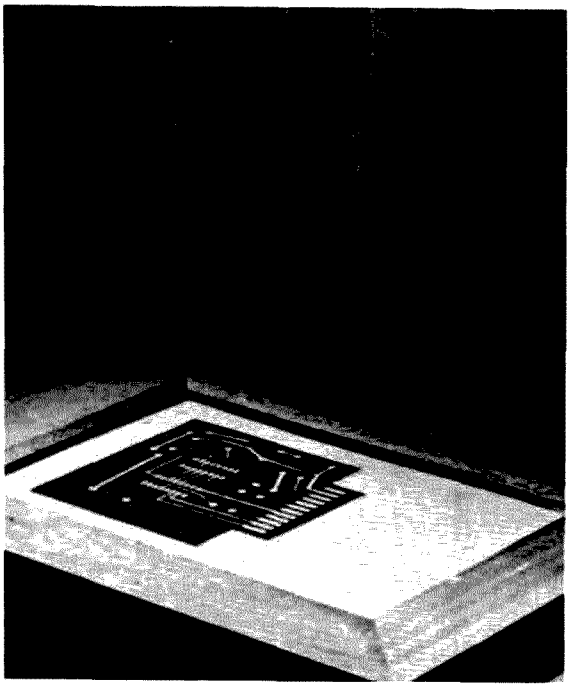
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Open the contact frame (or substitute therefor), placing the B-Neg face down on the glass. Make sure the sprayed board is completely dry and place the 'resist side against the B-Neg. Close and lock the frame, and place it under the blacklight source about 3 in. from the lamps. Expose for two to four minutes (a test or two will give you a



Step 6. Exposure to ordinary black-light fluorescent lamps takes less than four minutes.

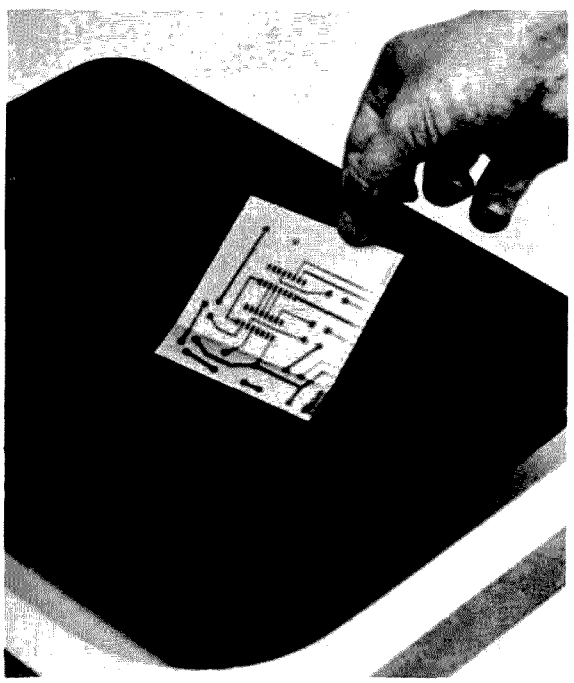


Step 7. It takes only a few seconds for a crisp pattern to show in the developer tray.

reliable guide). If you use bright sunlight, allow 10–15 minutes around noon.

Immediately after exposure, immerse the board in the developer. Agitate gently; 30 sec to 1 minute should produce a bright, sharp image. Now rinse in running water at the sink, where etching and stripping will soon complete the process.

To etch the board, dissolve one packet of Bishop etchant powder in a pint of hot water in a *plastic* tray. Immerse the exposed



Step 8. The developed board is immersed in a solution of Bishop etchant and left for an hour.

and developed board. In about an hour, the board will be fully etched. Gentle agitation from time to time will speed the process. Hot water around the plastic tray will keep the etching solution warmer, speeding the process.

As soon as the etching process is complete, pour some Bishop stripper over the board, and, with water running over it, rub the stripper over the pattern until the copper is glossy . . . and all the dye is removed. Then dry the board and it is ready for drilling and assembly.

When you add the prices shown in the table, you may feel that the overall cost of producing your own boards is prohibitive. And of course it *would* be for a single board. But the amounts of chemicals you get are sufficient to turn out quite a few printed

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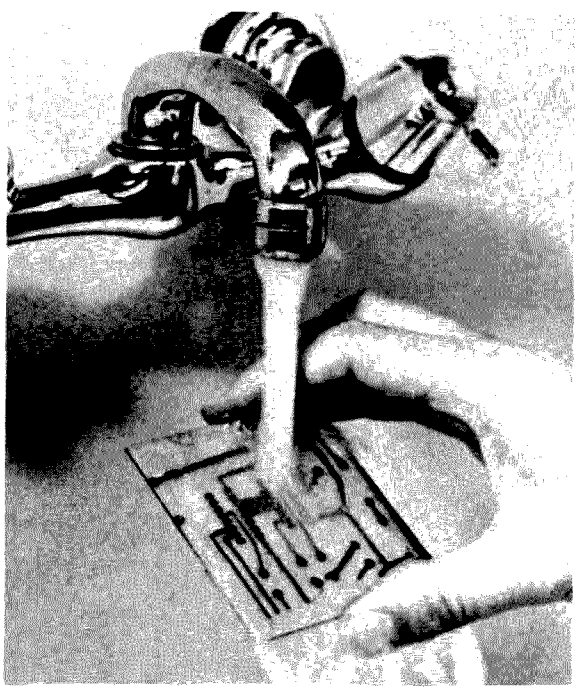
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Step 9. While rinsing in water, Bishop stripper is rubbed on the pattern, removing all dye and leaving a finished board, ready for drilling and assembly.

circuits. For a club project, there just *can't* be a cheaper way to get a lot of professional boards. . . . K6MVH ■

Feature This



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how I read the Radio Operators Handbook and found happiness



. . . and he thought a logarithm was the beat of a jungle drum

R. W. Johnson
31 Maclarnon Road
Salem NH

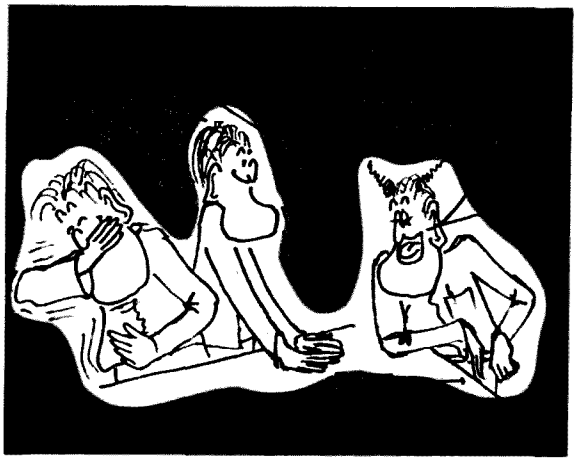
There are one hundred fifty-four million ham operators living on my street. Some of them sleep six to a room. Together with the thirty-two thousand at the office that I work with and socialize with every day, you can probably well imagine that for some length of time, I have felt somewhat alone if not downright black-sheepish. considering the fact that up until last Saturday evening, I didn't know the difference between a waveform and a potentiometer. For years,

whether at parties or the water cooler, I felt left out.

Don't get me wrong! I'm not insinuating that the ham population has grown to unhealthy proportions or anything. All I'm saying is that when the time comes that a milkman or grocer or any other normal type of unassuming personage such as myself develops serious psychological traumas because of an inability to discuss capacitive reactance with every Tom, Dick, and Alfred, then one must do something. What one must do is largely up to oneself. I – having a very agile and analytical mind – chose to acquire an education in electronics.

So last Saturday I read the amateur radio operator's handbook –from cover to cover (minus the ads). Granted, this doesn't make me an engineer. But you wouldn't believe how it has changed my life. Things are different now. I not only feel confidence in my relationships with my contemporaries, but –and get this– I actually feel *a little cocky*. Don't laugh! I know what you're thinking. *Here's a guy who reads something and comes on like the guy who wrote the book.* Right? Isn't that what you're thinking? For my defense, I submit that all things are relative (I didn't make that up; I read it somewhere). What I mean is simply this: My knowledge on Saturday night compared to my knowledge on Friday night makes me something of a Marconi–Faraday–David Niven conglomerate. It's unbelievable how my life has changed. My confidence is not unlike that of a Karate black-belt.

Like yesterday, for instance, I went into the local Radio Shack. I didn't need a thing. It was just a place where I could feel at home –*wanted*, if you will. I asked the electronics guy if he had any microfarads, and you could tell he was really impressed because he didn't say anything for a while. He just sort of looked around and blinked a couple of times. He asked me if I was putting him on. I assured him I wasn't and he muttered something that I couldn't quite catch, and called a couple of other guys over to meet me. Their names were Chuck and Lennie, if my memory serves me right. Anyway, the four of us stood around smoking for a while and talking about this and that. Chuck and Lennie were a couple of pretty good guys. Lennie kept giving me cigarettes and lighting them for me. You could tell he wanted to keep me around for a while. Then, the first guy I had spoken to asked me how many microfarads I wanted. I told him I could use about a handful (I knew



they had to be cheaper in quantity orders). "Wouldn't use anything else," I said with a sly, knowing smile. You could tell they got a big kick out of this because Lennie kept nudging Chuck.

Now don't get me wrong. I'm not bragging or anything. That's not the point of me telling you all this. This is just to illustrate what a little erudition can do.

When I left, Lennie, Chuck, and the other guy were all hee-hawing their heads off and slapping each other's shoulders and everything. Chuck looked like he was ready to roll on the floor. Boy! You could tell that they really enjoyed electronics.

Like I say, though, life is different for me now. I can *talk* to people. I really can! New worlds have opened up to me. I feel comfortable – contented – relaxed– IN!

A few days ago, I put a dipole on my roof. It's beautiful. The ole sun reflects off that thing like there was no tomorrow. And the gleam is enough to knock your eye out (what kind of wax do you use on those things anyway?)

Hank, my next door neighbor, says I ought to get a "rig" for it. But I figure it can wait a while. First things first, you know. I'm in no hurry. I figure: today a dipole– tomorrow an ohm.

. . . WOW ■

The first eight years of amateur FM repeater operation in the United States has been a period of growth and stabilization. Today, because of the unprecedented popularity of repeaters and channelized operation on the VHF amateur bands, we are faced with such problems as:

- *Frequencies for new systems*
- *Channelizing*
- *Logical frequency pairing*
- *Deviation and bandwidth*
- *Tone frequency standards*
- *Guard channels*
- *Command methods*
- *Selective calling standards*

Many systems have grown in their present shapes because of availability of equipment, bulk availability of crystals, long-term usage on certain channels, patterning from a successful scheme, or because it seemed the thing to do at the time. In most cases, changes were made before cost prevented modification and systems developed so that members were served as necessary. But now it is 1970, we are thinking nationally—and for good reason. Travelers report that directories are inaccurate and that they have found activity not quite as reported or that the local repeaters are tone-protected. Frequencies in one area are not used in another. Interconnection presents problems in selective calling and command. Multichannel users compromise equipment performance. One area is narrowband, the other wide. So-called national frequencies are used with a variety of input frequencies, depending on area. UHF users find a wild variety of pairings and come to the conclusion that this band is haphazardly planned with frequencies confidential.

But all is not so bleak. With a little forethought, users can plan together, applying techniques known as spectrum engineering, frequency administration and conservation, or whatever name suits. It has been done with great success for the past two years in the west and I'll wager that with a little intentional planning that even in Los Angeles — that great super hodge-podge of "secret channels" and RF overlay — a measure of order will result in the next five years. Let's take a look, then, at what we can achieve and how to go about it with minimum outlay.

First there must be some form of mutual planning, whether on an agreed basis, by meetings of the repeater groups in a state or area, or by the principal repeater group taking the initiative. Acceptable standards can be determined and, though planned changeovers would meet with little acceptance, any changes could conform to agreements. Most amateur relay systems have changed enough in five years to prove they are fluid. In some concentrated areas of relay activity, coordinators, gentlemen's agreements, or adherence to accepted plans have been very successful. To my knowledge, very few systems have gone into service haphazardly and without thought. Those that ran into technical or operational problems soon changed because of opposition or impracticality.

NEW RELAYS

Where is there room for additional groups, especially in areas of intense usage? By being careful with the spectrum — that is, by channelizing and establishing standards of bandwidth — the greatest number of channels can be rendered with full compatibility. A generally accepted plan for 2-meter FM operation, for example, is each 60 kHz up from 146.04, leaving the lower portion to AM and DX'ers. Greatest activity still seems to be the upper portion of 146 MHz. A significant amount of narrowband FM equipment is available and the 30 kHz channel standard on 2-meters could within five years fit in very nicely, rendering 32 discrete channels. I see no problem in using this plan, then selecting a suitable deviation standard for one's own purposes. The equipment is made for either 5 or 15 kHz; anything else is a compromise in performance.

Six meters is less intensely used and 52.525 MHz seems to be the most popular for wideband operation. Narrowband operation does exist in some areas, from

51.0 to 52.0 MHz, on a 25 kHz channelizing plan. TV high-pass filters, though limited in effectiveness above 52.0, will help prove to TVI complainants that they often eliminate problems. AM operation stays low on 6 for reasons of self-preservation.

The 450 band is a world apart. Only the coordinators and trustees seem to know what really is in service and all admit there is more than meets the eye up there were channel frequencies are semiprivate. In Los Angeles as well as other places, for example, 50 kHz channelizing is the rule except that in L.A. ALL channels have been used above 440 and a coordinator tries vainly to keep accurate records. Those who prefer to go it alone find someone is sharing the space. Pairing is not in vogue just yet but efforts have been made to standardize, and several nets have adopted 5 MHz separation utilizing 440-444 outputs with 445-449 inputs. TV repeater experimenters have been a potential hazard, but recent concessions, after realization that FM'ers are serious, agreed to TV in the 435-440 portion of the spectrum. 450 is looking better each month as those who use this band for mobile operation see the value of planned pairing and reconfigure frequencies for better usage.

PAIRING

Armchair planning is always subject to criticism and rationalizing why it won't work. Moreover, existing nets complicate the matter. But let's look at what is being done in some areas and consider it for future planning in others.

	RELAY OUTPUT	INPUT
6 METERS	51.000	51.600
NARROWBAND	51.025	51.625
15 CHANNELS	51.050	51.650
	51.075	51.675
	51.100	51.700
	51.125	51.725
	51.150	51.750
	51.175	51.775
	51.200	51.800
	51.225	51.825
	51.250	51.850

		UNPAIRED
2 METERS	146.610	146.010
NARROWBAND	146.640	146.040
13 CHANNELS	146.670	146.070
	146.700	146.100
	146.730	146.130
	146.760	146.160
	146.790	146.190
	146.820	146.220
	146.850	146.250
	146.880	146.280
	146.910	146.310
	146.940	146.340
	146.970	146.370
	146.400-146.580	
		UNPAIRED
	146.940	(GUARD
	51.275.	51.875
	51.300	(GUARD
		CHANNEL)
	51.325	51.925
	51.350	51.950
	51.375	51.975
	51.400 - 51.575	
		CHANNEL)
450 MHz	440.050	445.050
100 CHANNELS	444.950	449.950

This arrangement aims at compatibility with other amateur operation, best utilization of the spectrum, and extension of existing FM relay systems. It is placed in nomination as a national plan.

TONE

Overlapping repeater coverage on the same channels as well as the desirability of multichannel compatibility brings us to the realization that pulse tone must be standardized where used. If pulse tone entry is planned, choose standards and hold to this plan

Touchtone is gaining popular acceptance for control and signaling in some areas and probably will dominate as ability to produce good decoders becomes more widespread. This is an excellent approach for the more talented groups.

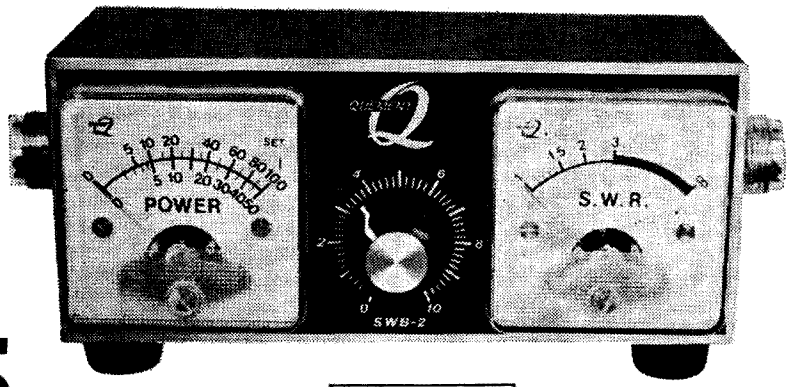
GUARD CHANNELS

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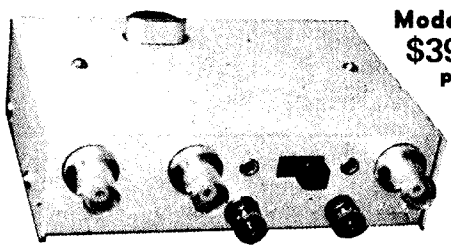
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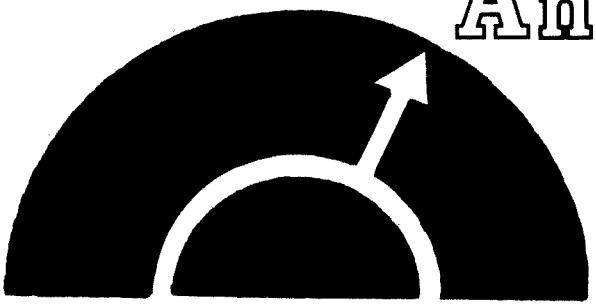
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idea of guard channels has become an acceptable solution and has proved successful where implemented. 51.3 and 146.94 are logical choices here, having been sanctioned by the California Amateur Relay Council as a regional solution. By guarding these channels or using a receiver scanner which samples more than one channel, a surprising flexibility is possible. By guarding one's regularly used channels plus the common calling and working frequency, we can provide ourselves with even better systems, both at home and while traveling.

The first eight years of repeaters has taken us through a period of organizing and building. Let's let the next eight be devoted to sophistication and joint planning. With good nonrestrictive repeater regulations a good possibility within a year a fine magazine to spread the word and cement us together, and the enthusiasm we all possess, the future looks promising indeed.

. . . WB6DJT ■

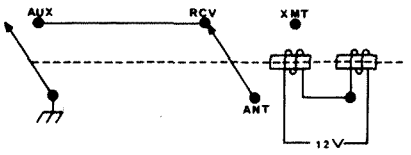


An Inexpensive RF Wattmeter

Walt Pinner WB4MYL
7304 Lorenzo Lane
Louisville KY 40228

While on vacation recently, I was rummaging through the various surplus outlets in the Detroit area. Among the goodies purchased was a small surplus "Antenna Current Indicator." It has a 2½ in. meter movement, three spring-loaded feedthrough connectors, and a power plug for connection to an internal antenna relay. It also includes the pickup unit and shunt necessary to operate the meter. The unit is a thermocouple-type antenna current indicator. Its nameplate states it was manufactured for the Army Signal Corps under the name of "Antenna Current Relay Unit BC442-AM."

The unit has a fitted bottom cover and ample room to install two SO-239 connectors in place of the feedthrough connectors already there. The antenna changeover relay is mounted to a plate and secured to the box with four screws. It may be removed as an assembly for use elsewhere. The rf contacts appear to be more than adequate for amateur use up to the legal limit of power. The rf contacts have an additional single-pole contact which may be



used for B+ control or grounding of the receive antenna lead during transmit, as shown in the diagram.

The relay is operated by two series-connected coils and requires +12V at 80 mA. If the coils are parallel-connected, a 6V source may be used. A single diode with a small filter on the rig's filament supply works nicely.

The meter scale reads from 1 to 10. Comparison readings of this unit, with no change other than substituting standard coax fittings, were made against a Drake W-4 wattmeter into a 50Ω dummy load. The results are tabulated below:

BC442 reading	Power (watts)
1	100
2	200
3	300
4	400
4.9	500
5.5	600
6.2	700
6.9	800

These readings remained constant over a range of frequencies from 3.5 to 30 MHz. Power levels of 25, 50, and 75 watts may be read with reasonable accuracy if the mechanical zero meter setting is adjusted with the meter in the vertical position and the power readings taken with the meter in the same position. The best part of this unit is its price. It was purchased from Bauer Industrial Supply, Redford Ave., Detroit, Michigan for $3.00, less his 15% discount (to anyone) which lowers the already ridiculous price to $2.55 plus tax. A terrific buy for your surplus buck.

. . . WB4MYL ■

Sam Craig W2ACM
5812 Tilton Road
E. Syracuse NY

A REMOTE MULTIFREQUENCY

A simple method for modernizing your surplus FM unit by adding those extra channels.

If your VHF FM gear is a single-channel type and you have been wondering how to add multifrequency capability, here is your answer. This article describes a remote crystal oscillator with switch selection of up to four crystals.

Since the original unit was intended for the transmitter of a GE pre-Progress Line ES-1B 2 meter FM unit, 3 MHz crystals were used. The circuit should work equally well with crystals of other frequencies (up to 15 MHz or so), and it can be applied to receiver local oscillators as well as transmitters. It is not designed to work with overtone crystals, however.

The circuit, Fig. 1, consists of a transistorized Pierce oscillator coupled to an emitter follower for isolation and low output impedance.

The oscillator unit may be mounted in any convenient location and coupled to the transmitter by a length of ordinary shielded cable. Neither the type of cable nor its length appears to be critical. In the original installation, a four-conductor shielded cable having a length of about 6 ft was used. The output impedance of the circuit is low enough to tolerate the shunt capacitance of 15 ft of shielded cable or coax without any drastic reduction in output voltage. Impedance matching is not necessary, since optimum power is not a requirement.

The rf output from the remote oscillator is fed directly into the grid of the former

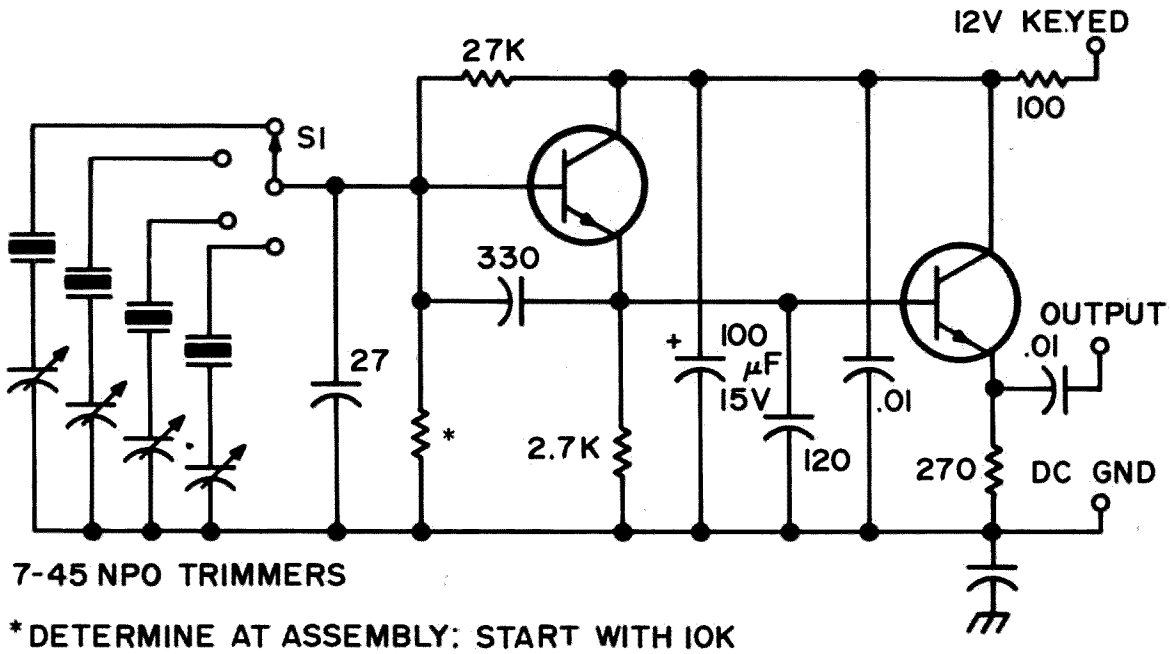


Fig. 1. Remote multifrequency oscillator schematic.

OSCILLATOR FOR SURPLUS FM UNITS

oscillator tube in the transmitter, so that this stage now becomes a buffer. The cathode of this tube (and screen, if a pentode) should be bypassed to ground for rf if not already done in the existing circuit. In my installation, the grid current in this stage was not as high with the remote oscillator as it was originally, but the drive level in the subsequent stages was unaffected.

The output frequency is not affected by the load, and changes only a few hertz when the supply is varied between 5 and 15V. Although the output voltage increases as the supply voltage is increased, the use of more than 15V is not recommended.

The oscillator consists of a two-board "sandwich" and a third board, which mounts perpendicularly to the other two, as shown in the plan view of Fig. 2. The actual size layouts of circuit paths for all three boards are shown in Fig. 3.

Once the etched circuit boards are made, assembly of the unit is quite simple. After soldering the components to the main circuit board (see Fig. 4), attach the output, power, and ground leads and mount the board in the Minibox. Be sure that leads and solder do not protrude more than 1/16 in. on the foil side of the board. Then attach and wire the connector (J1). Next, the rotary switch (S1) should be put in place and connected to the main board. The remaining two circuit boards with the crystal sockets and trimmers are fastened together and mounted last in the box. The front of this assembly is supported by the leads from the boards to the switch, so no size smaller than 20 AWG solid wires should be used for mechanical

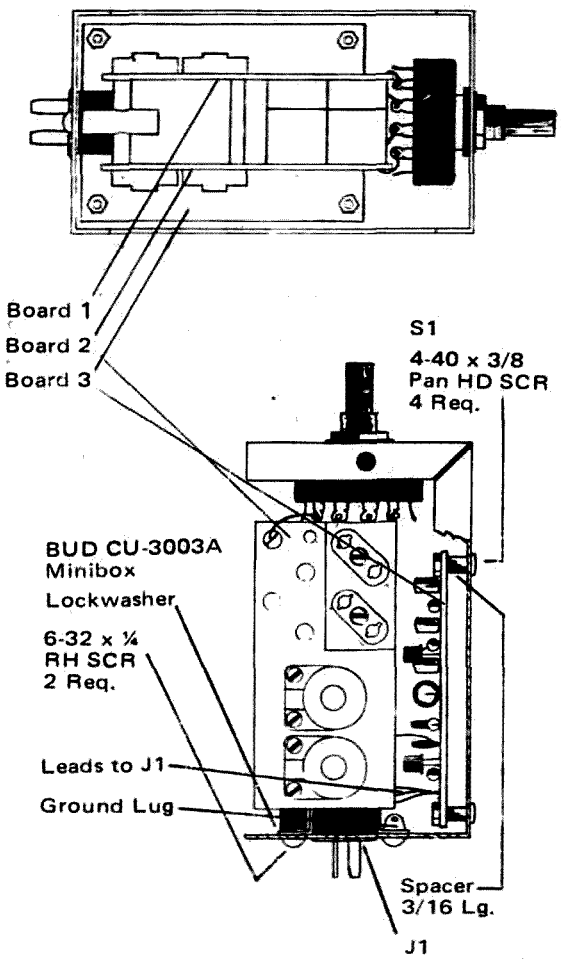


Fig. 2. Layout of oscillator.

stability. Use care when inserting or removing the crystals so as not to crack the circuit boards. Glass–epoxy board material is worth using, if available, because of its greater strength. Figure 5 shows the construction and layout detail for the two-board sandwich. When adjusting the trimmers for

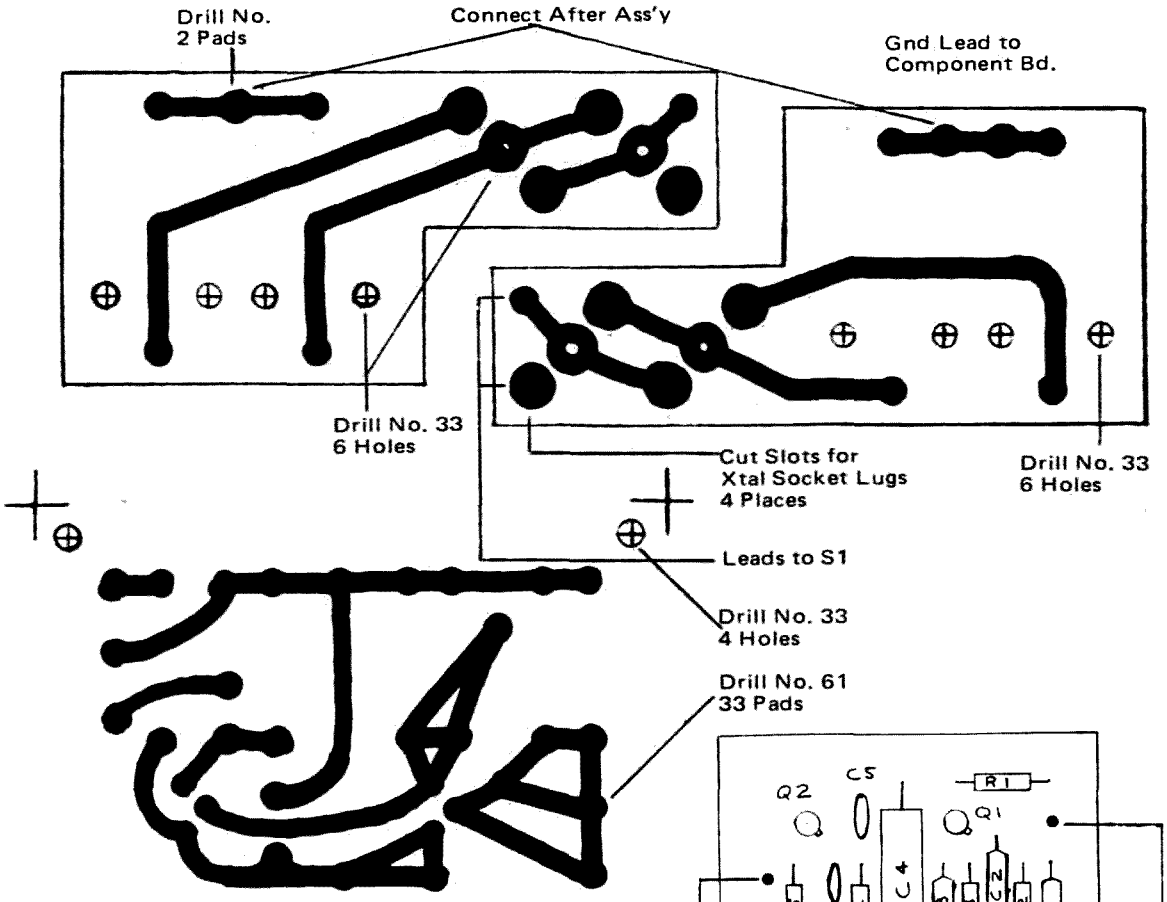


Fig. 3. Actual-size printed-wiring layouts for the three boards.

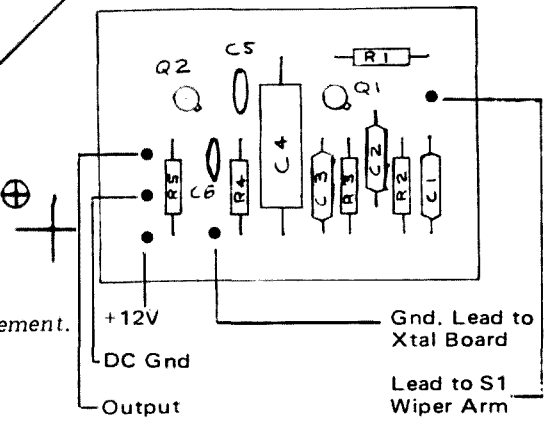


Fig. 4. Main circuit board component placement.

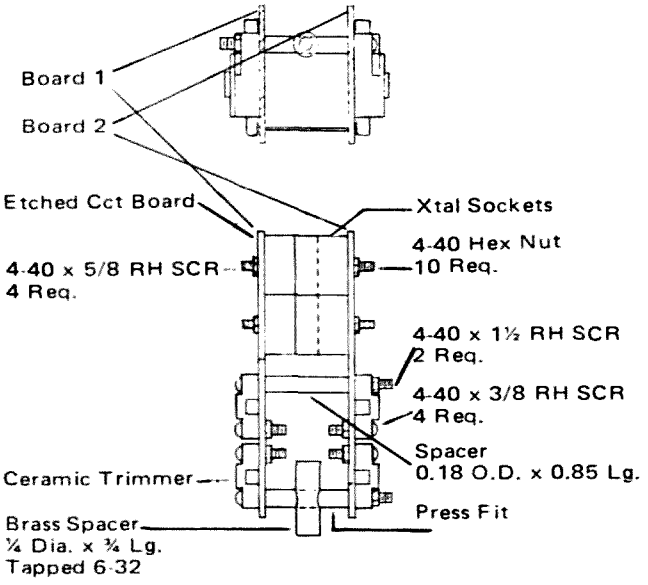


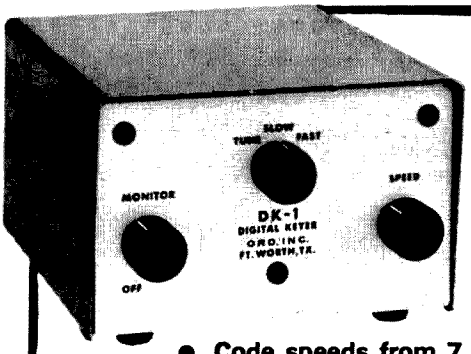
Fig. 5. Vital statistics for the two-board "sandwich."

exact frequency, remember that placing the cover on the box will lower the frequency slightly (10 to 20 Hz with 3 MHz crystals) due to the added capacitance. To avoid this problem, holes can be drilled in the cover for access to the trimmers. Because of its small size, the oscillator can easily be taken to a counter or other measuring equipment for accurate frequency adjustment.

Measurements of thermal stability have not been taken yet, but experience has shown that in the usual mobile environment the frequency does not change enough to be evident at the receiving end.

I am indebted to N. V. Friend, who furnished the idea for this device.

. . . W2ACM ■



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"L"—Close dot key. During the first dot, flick the dash key. Release dot key during the last dot.
"B"—Close dash-dot key. Release dash key at any time during the three dots and dot key during the last dot; or, release dash-dot key during the last dot.
"Double Dash"—close dash-dot key. Release dot-dash key during the last dot or dash.

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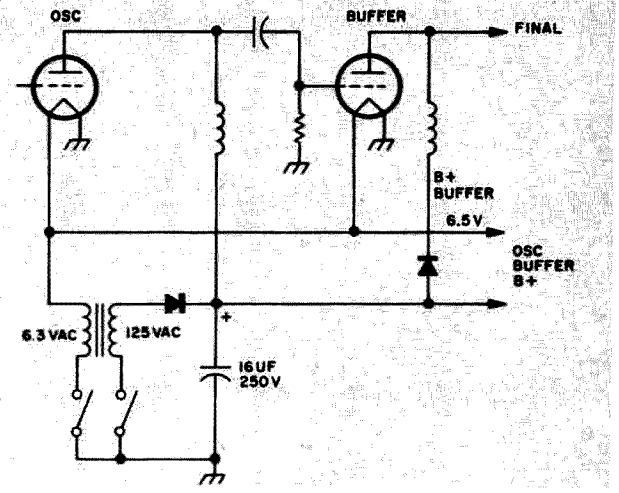
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After some experimentation, I came up with the circuit shown here. As shown, I connected a double-pole (single-throw) switch in both ground leads of the transformer primary and secondary windings to prevent feedthrough when regular B+ is applied as the rig goes into the regular transmit mode.

A diode in the B+ to the buffer prevents it from operating when spot checking and still allows regular operation.

. . . K8BYO ■

TOWARDS AN IDEAL SOLID-STATE I-F FOR AMATEURS

PART 1 LOW FREQUENCY MODULES USING ICs

. . . and believe it or not, 455 kHz isn't it!

William Hoisington K1CLL
Far Over Farm
Peterborough, NH 03458

This article is a two-part series that deals with design methods, components, and circuits using solid-state devices leading to an i-f system that will meet the special requirements of the amateur builder who wants a reasonable-cost, selective, low-image, tunable i-f for use following converters on 6 or 2 meters, or the UHF regions above 420 MHz. This portion of the series describes design details of the 1.65 MHz and the 135 kHz i-f modules, using subminiature shielded coils and ICs.

Requirements

Selectivity and Freedom From Images. The easiest way for the homebrewer to get selectivity is to use a low intermediate frequency; however, this cannot be done without suffering from image trouble unless

several conversions are used. An image is the unwanted signal on a frequency separated from the desired signal by twice the i-f. This is caused by the presence in a mixer collector circuit of several frequencies other than the desired one. For example, if the local oscillator is on 28.5 MHz and the desired signal is on 28 MHz, a beat note at 0.5 MHz will be produced, which is used for the i-f.

Unfortunately, a signal on 29 MHz will also produce a beat note on 0.5 MHz. This unwanted signal is called the image; you can see that it can cause considerable strain on the selectivity requirements of the rf and mixer stages in a 10 meter receiver in order to remove it. This is one of the main reasons for multiple conversion amateur receivers that use a first i-f of 1.65 or 2 MHz, which places the image some 3.3 to 4 MHz away from the desired signal. Here it can be handled by the selectivity of the two tuned circuits of the rf and mixer stages generally found in such a receiver. The requirement for reduction of the image is met in this fashion in our "ideal" i-f.

Tunable I-Fs. The use of converters with crystal-controlled local oscillators for stability reasons requires tuning somewhere else down the line. For the fellow interested only in a large, stay-put home station, this can be accomplished by using his 100 lb communications receiver, with switched inputs, etc. However, that does not meet our planned types of operations, such as battery-portable-anywhere, mobile, and emergency use, all of which are applications well suited for solid-state devices. A tunable, selective front end with rf stages, mixer, and tunable oscillator does the trick.

Practicability. The next requirement is for available components at reasonable cost. The J. W. Miller Co. has produced a line of shielded, subminiature adjustable rf coils (9050 series) which fill the bill for inductors. They have a threaded core of powdered iron in the center for trimming, an outer magnetic shielding cup which also helps the Q, and an aluminum case for electrostatic shielding (½ in. square by 9/16 in. high). They also are handy because you can easily add extra windings—for coupling with solid-state devices.

Resistors in the 1/8 and 1/10 watt range are available at most mail order houses, along with subminiature capacitors. Subminiature terminal pins have been described in my own previous articles in 73 Magazine.

Active devices having high gain and low internal feedback, that do not need neutralization, are available from Motorola. The HEP 590 is one of these; it is easy to use and performs excellently.

Demodulation Characteristics. These articles being mainly concerned with AM on VHF and UHF, the demodulation is important. This is given scant treatment in many handbooks, but I find that when you're actually digging those call letters (at least!) out of the mud, you need the best possible diode circuit available. It seems, from all the tests I've made, that the diode demodulates more af when connected across the entire winding of the last tuned circuit.

AF Amplification. Next in order of importance comes a good af amplifier. There is no doubt at all in my mind on this one. The Amperex TAA-300 is it. It has 1W output, a response of 20 Hz to 25 kHz, and an 8Ω transformerless output impedance, and sounds good. With bass and treble controls in front, it really does the job for voice communication frequencies for amateurs.

Single-Package I-F Pair. The last requirement (for now) is for a double-frequency i-f. This is just a handy phrase for the combination of the 1.65 MHz and the 135 kHz i-f in one package. You can put more gain—with greater freedom from feedback troubles—into the amplifier when the input is on one frequency and the output on another—a tried and proved method.

I-F Considerations

Let's face it, 455 kHz is not the best i-f for amateur communications receivers. Its use as an intermediate frequency dates from the early 1920s which is by now nearly 50 years ago, and was intended for the broadcast band. There was and still is a good reason for using it on the BC band: It is the only i-f that even partially suits a "cheapie" BC set. I say only partially because using a mixer on the BC band, without an rf stage in front, which many millions of BC sets do, you get images from 540 kHz up to about

690 on the dial. I have a $100 set that covers 540 kHz up to 54 MHz—it is an excellent set for the money and is invaluable for checking harmonics, oscillators, mixer outputs, and the like; but not having an rf stage, it does have an image on the low end of the dial.

Car radios, mostly working on the "me too" design theory, use 262 kHz for the i-f. The reason given: "greater selectivity." Sure, it is easier to get better selectivity with a lower i-f, but the image is worse also, so they use an rf stage. If this rf stage is properly made and tuned, it solves the problem on the BC band. And I'll take my hat off to most of the designers of car radios that I've had, as most of these have performed pretty well. For many years of mountain-topping on 2 meters, driving home after 2 a.m., I kept awake listening to "Grand Ole Opry" and such, and those car radios did a good job.

But what about amateurs? These bands begin at 160 meters, so up around 10 meters, with an i-f on 455 kHz, the image is only 910 kHz away! You can't really put an i-f in the middle of the BC band, so the next slot is up at 1.65 kHz, or near that point. This works out fine for the image problem, but now your selectivity has gone to pot.

Of course, you *can* use a Gonset-type i-f with selectivity of around 30 to 40 kHz. In fact, right in this article I describe a "nice little i-f" on 1.65 MHz, with just that kind of selectivity. It works fine with just a single conversion on 6 or 2 meters, but when the band opens, stay away from the low end! I was in Maine one fine evening on a little rise of 400 ft or so when 2 meters opened. I worked Washington D.C. and VE1, but I couldn't separate one signal from another on the crowded low end using my "tried and true" Gonset III.

So, it is probably best to devote the extra time and money required and try for the ideal i-f, which conquers images and provides excellent selectivity at the same time. There are two components which help the home-brewer reach this goal: the Miller Series 9050 subminiature coils and the Motorola HEP 590 communication IC.

Our ideal i-f will therefore look like the block diagram in Fig. 1. When designed, components selected, the circuit formed up, and packaged with its small battery supply, it should be a useful addition to amateur VHF, UHF, and microwave equipment.

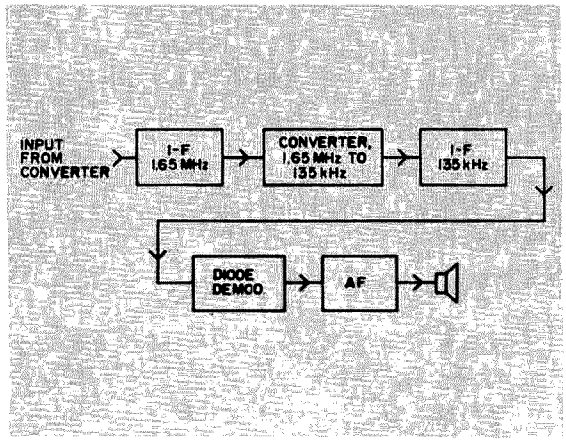


Fig. 1. Block diagram of the "ideal" i-f for amateur use.

Miller Series **9050** Coils

Here is something good, that you can really tailor to suit your needs. **Figure** 2 shows the inner workings. The Bakelite base is normally supplied with two pins, but is easily drilled for four extra wires (which you need for a link-coupled base input, for example). The coil form has a neat spiral ridge inside to take the 6/32 in. threaded

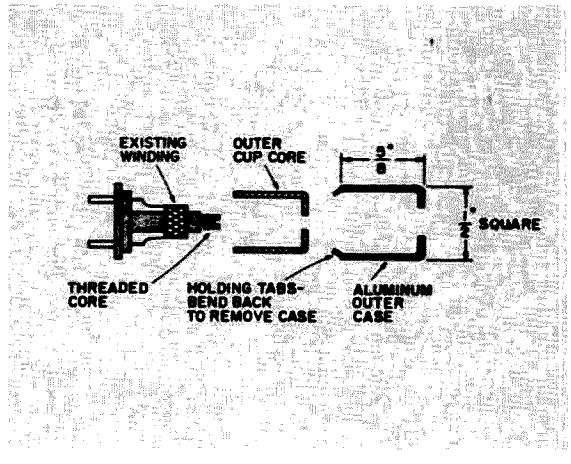


Fig. 2. Miller coils, 9050 series.

core. This ridge type works better than some other types of coil holders I've used. The outer powdered iron cup generally has room between itself and the existing winding for the few extra turns needed in solid-state work. The aluminum outer case comes off easily enough after you bend back the four crimped aluminum tabs on the case that hold the coil form in place.

As you will see in the section on coil data, you can wind on 1-10 turns of link coupling and a 5-turn base coil, both on top of the existing winding, for a base input network. I used a small drill to make more holes in the Bakelite end piece to bring out the extra wires, and find the entire series adaptable from 30 MHz down to 135 kHz; and the good Q resulting from the use of these coils is particularly noticeable in the overall selectivity figure of the finished i-f. **Figure 3** shows one of them with an extra

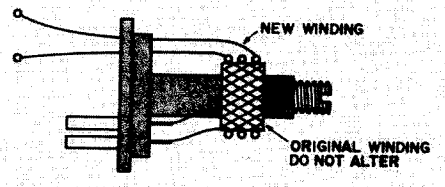


Fig. 3. Two holes at the bottom of the coil permit the two additional leads to be brought out with the original windings.

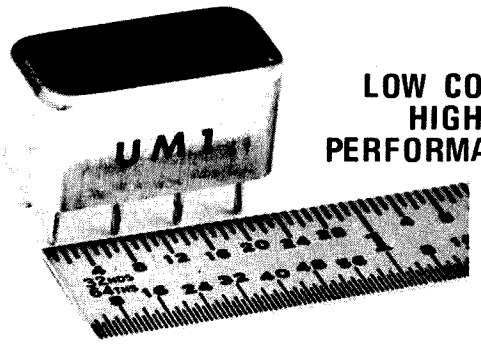
three turns installed. Until Miller comes up with something better, these are my coils.

Loaded Q vs Turns. Various sections of a communications receiver i-f have different amounts of loading, which affects the Q and energy transfer. For example, the HEP 590 input circuit works well with only a single-turn input link at 1.65 MHz, while at the same frequency a 5-turn link is required when going into the diode circuit, which is heavily loaded.

The HEP 590 output circuit, rated at 100 kΩ ac impedance, needs only 2 turns for maximum transfer of energy into a 50Ω cable or link to the next stage. Naturally, a lot depends on what impedance you're looking into, or out of, and how it is treated. The HEP 590 input circuit, rated at 1.8 kΩ ac impedance—if loaded directly onto the inductor—will swamp the Q way down.

Looking at **Fig. 1**, you can see what has to be done for this type of i-f. A winding of the correct number of turns to suit the impedance of the IC is installed over the existing tuned circuit, which is resonated at 1.65 MHz. A cable input link of only a single

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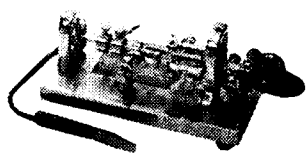
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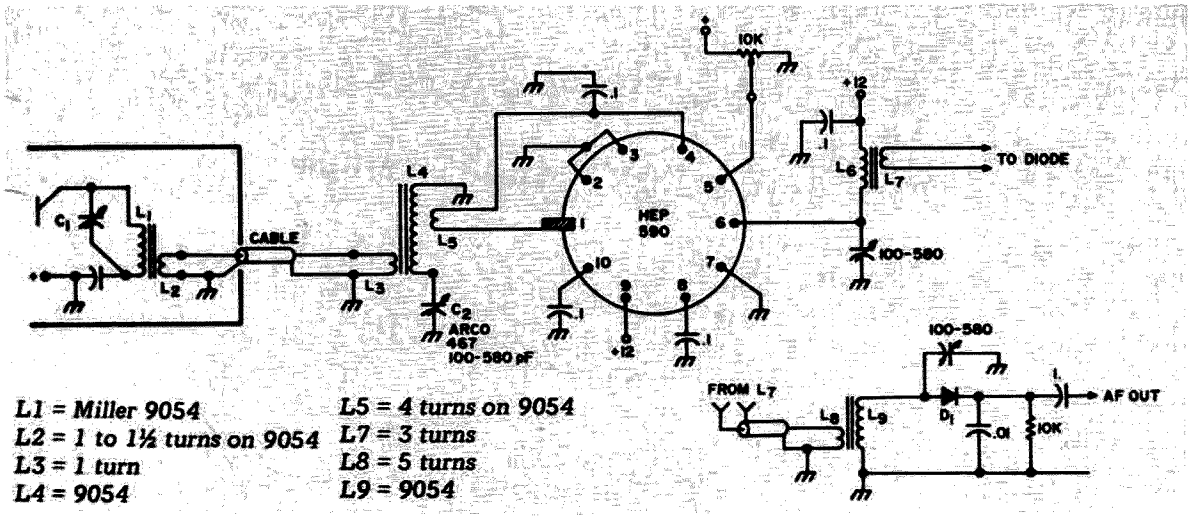


Fig. 4. Coil interconnection and winding data. At left is VHF converter (Part II). Test diode demodulator schematic is shown at lower right.

turn is also wound over the same resonant circuit. Don't forget that the presence of the powdered iron both inside and outside aids this coupling. When the inductor is heavily loaded and the Q is lowered, the number of turns required to effect a transfer of energy may be as much as five times greater. This can also be seen in the coil table in Figs. 4 and 7. The base input is very easy to match by this method of varying the number of turns, as in Fig. 4 (L4) and in Fig. 7 (L3).

When using link coupling, which is very desirable at times *with modulator type units*, be careful not to couple too tightly (by the use of too many turns). This will show up as excessive detuning of one tuned circuit by the one link-coupled to it. It may also cause broad tuning. For maximum selectivity and proper handling, use slightly *less* than the coupling showing maximum energy transfer. Remember, *gain* is cheap, *selectivity* is not.

The 1.65 MHz and the 135 kHz modules will be described in the first part of this article, and the converter and avc detail in the next.

The 1.65 MHz I-F Module

This unit is what you could call a "nice little i-f." Following a 6 meter front end, it has *plenty* of gain, and selectivity of 30 to 40 kHz. It is also very easy to tune on 6 or 2 meters.

The schematic is shown in Fig. 4. Each of the seven windings, L1 through L7, has been the subject of considerable work and testing here, for selectivity and general handling properties. The tunable i-f or VHF converter shown at the left is the subject of other articles and is not taken up here. It does use one of the Miller series 9050 coils, though, as shown for L1, with but one turn added on to it for feeding the 1.65 MHz i-f energy over to the i-f module being described. Inductor L2 is installed on top of the existing winding of the 9054 coil. Also low in turns is L3, with only one turn being needed at 1.65 MHz, due to the high Q of the 9054 design. Coil L4 is another 9054, which has a third winding going to the base of Q1 in the HEP 590 IC. The input of the HEP 590 is rated at 1.8 kΩ.

The input tuning of C2 is very sharp due to the correct amount of coupling to L4 which has a high loaded Q. The HEP 590 communications IC and its advantages have been described several times in 73 Magazine, so only a brief mention will be made here. Inside the IC there are three transistors and a diode. The two transistors that do the amplifying are arranged as in Fig. 5, in a grounded-emitter, grounded-base pair, which is a high-gain configuration with no detectable internal feedback. The third transistor is connected as an avc unit, and the diode is used for temperature control.

Another Miller 9054 is connected to the output circuit on pin 6 and tuned by an Arco 467 mica compression trimmer of 100 to 580 pF capacitance. You can also get the needed capacitance by using fixed dipped micas and trimming up to 1.65 MHz with

the threaded-core tuning slug. If you do it this way, be sure to adjust the fixed capacitors so that most of the slug remains *inside* the winding for best coupling and Q.

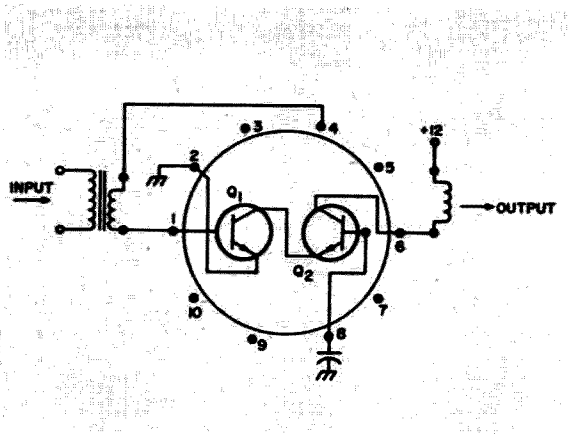


Fig. 5. Internal details, HEP 590, Motorola.

A 3-turn link winding is added to L6, which goes to an output connection. For tuning up, I used L8, L9, and a diode. When used with a tunable front end on 6 or 2 meters, this makes that "nice little i-f." Follow it with a good af and try it. You'll be surprised. It does not have ideal selectivity, but a 6 meter front end is wonderfully easy to tune with it!

Pin 5 of the HEP 590 can be used for a temporary manual gain control with just a

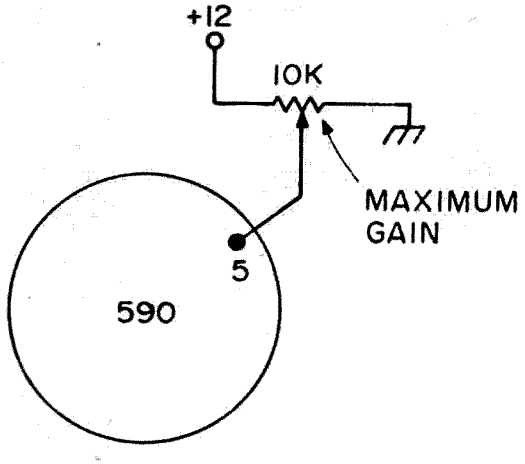


Fig. 6.

pot as in Fig. 6. Nothing else is needed. (The second part of this article deals with the avc circuit for use with pin 5.)

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135 kHz I-F Module

My bypassing of the converter module to describe the 135 kHz i-f may seem abrupt, but the work involved with the i-f coils and the IC units makes the continuity better this way.

Figure 7 shows the schematic of this module using the Miller subminiature 9060 coils (with added windings) and the Motorola HEP 590 IC. The circuit is quite similar to the 1.65 MHz version except for the output.

The Miller 9060 tunes to 135 kHz with an Arco 100 to 580 pF trimmer, but here again you can make up the capacitor with the small dipped mica ones to bring the 9060 near resonance and trim to the exact frequency with the internal threaded slug.

The input cable from the converter module (second part of this article) goes to L1, a 5-turn winding installed over the existing winding of the 9060. I use 32 AWG double cotton-covered for this and put small tabs on the input wires of coil L1 for identification. You can also use different colored wire if you have it on hand.

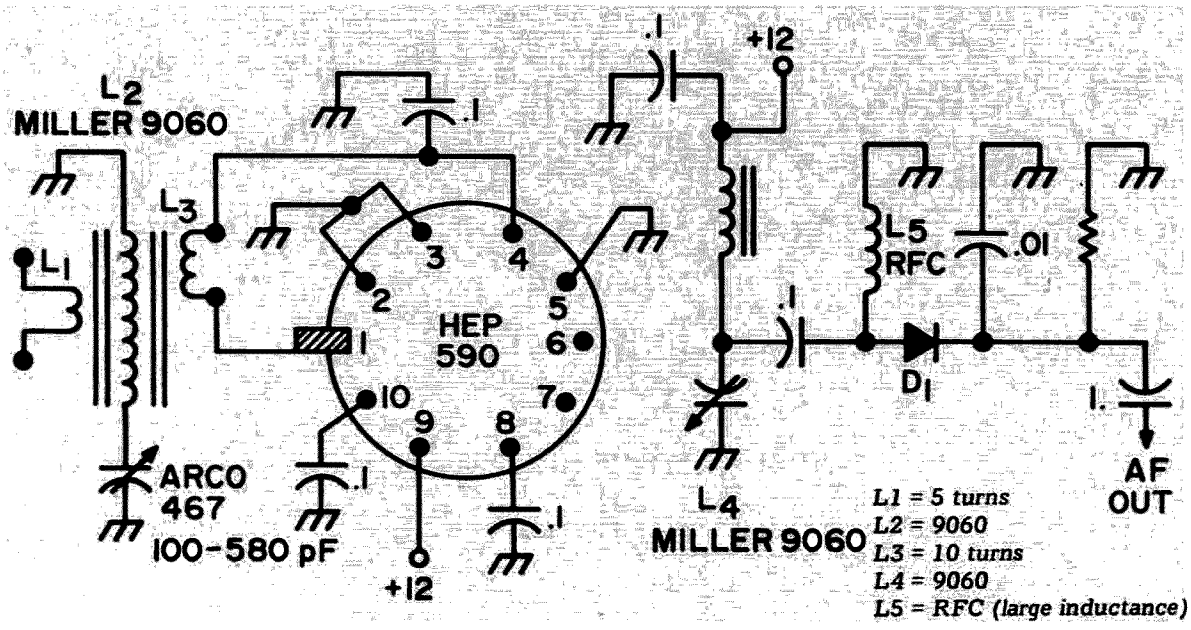
The HEP 590 was described in the first i-f section. It is treated identically, except that pin 5 is left grounded, keeping the gain full on, which is best for avc action because this is the unit that drives the avc diode and needs full gain.

The output coil is another 9060, with the diode connected to the *high* end. Some circuits call for tapping down the diode on the coil, but I have never found any connection as good as that shown in **Fig. 7** for high quality af output. Only two tuned circuits are shown here but there is a third in the converter module; the total selectivity is thus as sharp as you may want to use, because you can still recognize your friends' voices on the air. It is sharp enough so that using it on 420, for example, I have been able to separate the audio of stations that were heterodyning each other. Of course those $600 receivers can have crystals and 2.5 bandwidths, but that isn't the class of machine we're building here.

This first part of two sections on trending towards an ideal i-f system has covered the 1.65 MHz and the 135 kHz modules using modern coils and ICs. The aim is to build the best i-f possible, using reasonable-cost components and homebrew methods. The difficult requirements of an i-f with very low image characteristics and very high selectivity have been met. The second part of this article details the converter and avc systems.

. . . K1CLL ■

Fig. 7. 135 kHz i-f, with HEP 590 and Miller coils.



James P. Kirkgasser WA2ELA
105 Haddonfield Place
Dewitt NY 13214



The boys from Syracuse had a great time this summer doing something different. Of course, you have read about the idea put forth in 73 concerning Ham Hop, providing foreign hams places to stay when traveling about the U.S. We have already done something like this plus one better. We have set up "Ham Exchange."

This program is aimed at setting up hams going both ways, to Europe and to the U.S., with a home base that provides lodging and food at a ham's home. Thus, a traveler has a home away from home, plus the very important feature of cutting the daily living expense to the bare minimum.

The first test of the program was initiated by Fred Trode DL8VQ/W2, who enlisted the help of Uwe Rehage DL8QP to organize the DL side of the program. And we were off to our first and successful year.

Fred, my XYL, her sister, and four harmonics were the brave ones who met the charter aircraft at JFK airport at 3 a.m. on August 12 of last year. Of course there were the usual customs problems, including Eberhard (DJ9CJ) placing his passport in his luggage which went into the terminal when he needed it to get off the plane. After the normal fumbling in customs, the DL's were cleared at 5 a.m.

Fred crowded five of the hams and their luggage into his station wagon for the drive back to Syracuse where they met their hosts and the first ham exchange was off and running. My wife (Jo), with her sister and husband, took Eberhard and Ilse to see New York City and the one-time-only reception for the moon men. This was unbelievable as far as timing of the trip, etc., because our European visitors watched the Apollo XI all the way—including the walk on the moon (except Eberhard DJ9CJ), who fell asleep. I guess he had watched television eight hours straight and then pooped out at the first step on the moon).

A tour by sightseeing boat was perfect to get the feel of New York for our tired guests. Wall Street, Broadway, and the U.N. Building and two more days filled in the picture of New York City. Then we pulled the biggest goof in history—try and get through the traffic on the way to the first (hope the only one we have to go through) rock convention at Woodstock. Eberhard commented, "I have never seen so many cars boiling over in my life."

Once in Syracuse the variations on the exchange started. Some people wanted to travel, some wanted to work DX, etc. We had used 20 meters early in the summer to

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find out that travel was of most interest for Eberhard and Ilse. Boston, Niagara Falls, Montreal, New York City, and the local area were of prime interest. A trip was also arranged to Washington D.C. for Eberhard. Needless to say, we had a full four weeks.

I took a two-week vacation and combined it with the long Labor Day weekend to cover the areas outlined. We used a camping trailer for everyone including the children. This really cut the expenses and placed everyone in the person-to-person situation (where you can learn the most). One perfect Sunday was spent at Tanglewood, where we heard Erich Leinsdorf conduct the Boston Symphony in Beethoven's Ninth Symphony (Ilse's favorite). This is the main point about "Ham Exchange"—the people involved set up their own programs. Some traveled, some used Ham Hop, some sat home and drank beer and just got to know people.

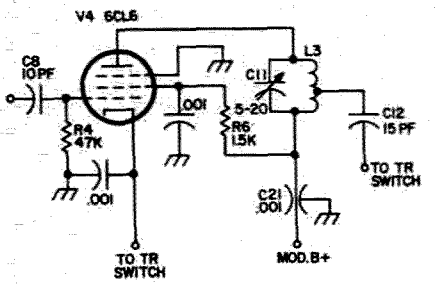
So this is "Ham Exchange." Write your own ticket! Travel to a new land! We will help find a ham at the other end who will provide a place to live and food. The rest is up to you and your host. We hit the road and covered the northeast quarter of the



United States. Out of pocket, it cost us about $350 overall for one month, which included a vacation for our family and two additional weeks including New York City, Niagara Falls, etc. For the fun we had, and for six people, this was quite reasonable. Now we are ready for next year, and we are planning our trip to Europe with our two children.

James P. Kirkgasser WA2ELA
Fred Trode DL8VQ/W2 ■

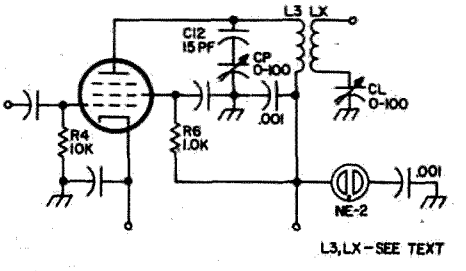
Larry Jack WA3AQS
3 Barry Avenue
Bay Ridge
Annapolis MD 21403



Unmodified Sixer final amplifier.

SUPER SIXER

. . . to the rescue

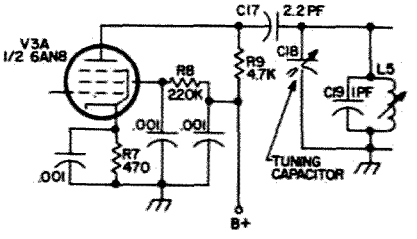


Modified Sixer final amplifier.

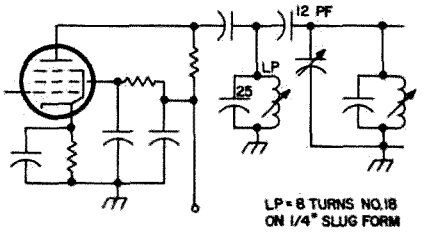
There's just something about a Sixer that can drive a ham crazy with "modification fever." Have you ever noticed the number of improvement articles written on them? It was a touch of such a "fever," induced by TVI, that got me digging into the bowels of my Sixer.

TVI has a bad way of catching up with you, sooner or later. Naturally, it wasn't too long after the little rig was first put on the air that a flood of complaints of television interference began. The use of a lowpass filter was obvious, though I couldn't bring myself to sharing the kW filter on the sideband rig with such a peanut whistle of a tranceiver. Why, the filter looked as large as the Sixer! There must be some other quick way around the interference...

On the premonition that C12 (15 pF) in the plate tank circuit was passing something other than just 50 MHz to the antenna, I changed over to link coupling. L3 was cut down to 6 turns and another coil of insulated wire, LX, of 2 turns was wound over it.

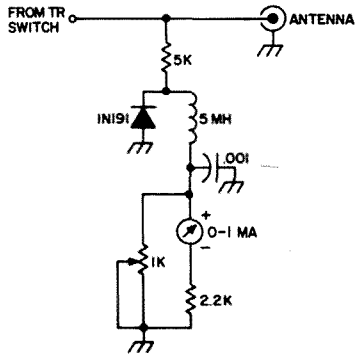


Unmodified Sixer receiver, rf stage.



Modified Sixer receiver, rf stage.

The results were amazing. The TVI was not only gone, but in addition, the transmitter loaded into the antenna better. This was great, so other modifications were begun.



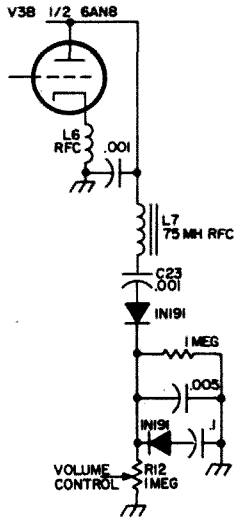
Improved tuning system.

Two holes were next drilled into the front panel, one to mount the new load control, and another for a capacitor to tune the plate of the final (6CL6). Two 0-100 pF variables were used because they were on hand at the time. The plate variable was placed in series with a 15 pF capacitor (the former C12), to make the tuning less critical at resonance.

Next, the grid and screen resistors of the final were changed from 47K and 1.5K to 10K and 1K, respectively. Input power increased two watts. Now some form of visual indicator for tuning the transmitter was needed. The original relative power output measuring arrangement of the Sixer leaves a lot to be desired. With a small light bulb as a dummy load, you can actually see a decrease in power when a meter is inserted into the circuit. A better, less lossy arrangement was substituted to sample the output rf. It is then read out on a 1 mA meter that was installed on the front panel.

Just for fun, a neon bulb was soldered in series with a .001 μF capacitor, and then to the cold side of L3. Instant modulation indicator.

The receiver section of the Sixer is its weakest spot. While the sensitivity is good, the selectivity is too broad to be usable when the band is crowded. A certain degree of selectivity was gained by adding a tuned circuit between the rf and detector stages of V3 (6AN8). How much selectivity was added, is hard to determine, but stations tune more sharply with less overload interference now.



Noise limiter.

Since the ultimate aim was to use the rig in a car, a noise limiter was tried. Even with the good limiting action inherent to a regen receiver, ignition noise was still a problem while operating mobile. From the Diode Handbook (73, Jan. 1968) came a circuit for a shunt diode noise limiter. One was installed between the detector and the first audio stage. Nothing truly spectacular resulted, for the ignition noise didn't disappear. It was reduced to a more tolerable level, however.

The crystal socket was moved to the upper right hand corner of the front panel. Instability was avoided by installing a tube shield over the 6CL6. And last, a 4PDT relay was wired in to allow PTT operation—a must when you're mobile. The Sixer was a nice rig to begin with; it's even better now.

. . . WA3AQS

Bob Manning K1YSD
Box 66
West Rye NH 03891

Bob, Bob, Bobbin' Along



K1YSD beside himself beside himself beside himself beside himself beside himself beside him

"This is K1YSD—mind if I get in on your roundtable?"

"Come aboard! What's the handle? Handle here is Bob!"

"It's Bob here, also!"

"Good enough, we got Don K1QES and Don K1NDA, and also another Bob WA1ACH on frequency."

"Oh swell. Say, Bob, what's your QTH?"

"Which Bob?"

"AOH."

"Mugwump Valley—but Don's got the best location."

"Which Don?"

"Whaaaaa me?"

"Me?"

"Who me? You call me? I was out in the sandbox."

"Who's this?"

"Don!"

"Which Don?"

"QES. Who's this?"

"Bob!"

"Which Bob?"

"YSD. Who said that?"

"Said what?"

"Said, 'Which Bob?'"

"Me, Don!"

"Which Don?"

"NDA!"

"Hey fellas, can I join the roundtable? My name is Herschel!"

"Herschel?. . .Herschel!!! You bet your sweet Aunt Matilda's hand knitted antimacassar you can join! Fact is, we'd appreciate it if you took over as the moderator of this group. Here's the situation as it now stands: We have three Bobs and two Dons on frequency. We can simplfy it if we label TFC as Bob 1, AOH as Bob 2, and YSD as Bob 3—then label QES as Don 1 and NDA as Don 2. Now, Bob 2 wants an informal with Don 1 and Bob 3 wants to talk to Bob 2—he has a message from Bob 2's son, Bob Jr. 4—Don 1 wants words with Bob 3 about what Howie 1 said to Howie 3 and Harold 2 about Don 2's meeting with Bob 1.

"Have you got all that Herschel?. . . Herschel!!!. . .Herschel???. . .Now, where the devil did he go?"

"I think I heard him mutter something like, 'Good Lord, I've tuned into the 'intra-happy-home-net' just before he pulled the plug!"

"Who said that?"
"I just told you, Herschel said it!"
"Yeah, but who are you?"
"Don!"
"Don who?"
"Number two—who's this?"

At this point something must have snapped, for the next thing I remember is clawing frantically through the metal and cloth grill, reaching in and disemboweling my MS-4 speaker (turning a $20 speaker into an 89¢ *frisbee*). Then, standing fully erect, and with all the force of a Paul Bunyan with prickly heat, I cleaved my Drake R4 into



two equal parts with my boom mike (giving myself two R2's, a chromium W.C. Fields cue stick and a possible double hernia).

Shrieking, "GERONIMOOO!!!, I hurled myself through the screened window—straining myself—counted ten and pulled the "D" ring which, as luck would have it, happened to be the snap fastener on my sansaband trousers, and went stomping down the by-ways of our otherwise normally quiet New England town, clad only in a terry cloth robe, knee socks and boondockers with a pair of earphones clamped on my head, from which dangled, 'twixt my knees, the earphone cord and ¼" phone plug, resembling either a grotesque umbilical cord or some other potentially hysterical physical malformation . . . still clutching the misshapen boom in my hand. (I still wake up nights with the memory of a wild-eyed, horny, but impotent shepherd clomping and frolicking ungainly—not unlike a rhinoceros in heat—down the road to the tune of "Hippity Hop to the Barber Shop.')



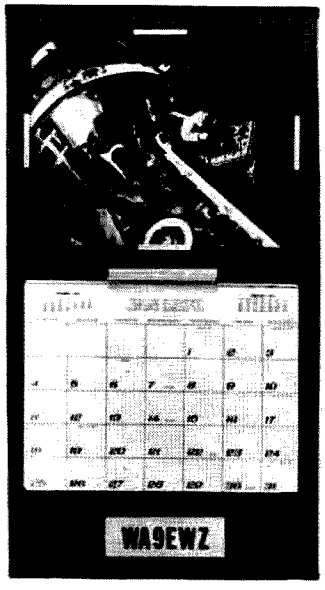
I kept up a continuous chanting mumble of, "I'm Bob, no—you're Bob, I'm Don, he's number two, you're Don, he's Bob, I'm number one—Herschel! Herschel?? *Who the hell is Herschel??*"

I might well have gone on like this forever and, since it was summer, there's a good chance I'd have reached route #1 (Blood Alley) and been scrunched into unrecognizable mush by some boat-hauling, arm-dangling, gum-chewing, antique-collecting kamikaze driver from Massachusetts, possibly adhering to one or more of their treadless retreads (though this would have made me a big man in concentric circles, I must confess ,that I had no real desire to become a permanent part of the Spaulding Turnpike).

Every summer, these juggernauts—with the instincts of the suicidal lemming and the finesse of a "dropped rock," burst into our State like mindless shrapnel from a fragmentation grenade.

They come, on their annual pilgrimage, like a horde of soldier ants, or locusts, firm in the belief that not only is the shortest

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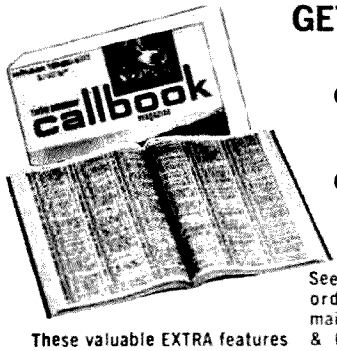


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distance between two points a straight line, but that the Massachusetts plate gives them license to disregard any and all safety precautions and that nothing should—indeed, nothing could—stand in their way.

Ensconced in a formless, unidentifiable 2000 pound mobile pig-sty, held together by Band-aids, inspection stickers, rusty wire, primer paint, ding-a-ling decals and a modified law of inertia, which, in this case, states that the vehicle—once set in motion—must not only remain in motion, but must do so with ever increasing speed mathematically proportionate with the distance covered, accidents caused and terror instilled in New Hampshirites. Failure to comply will result in instantaneous disintegration, creating either a 'Susan Spotless NO! NO!' or a new ski area complete with 200 foot bar.

Dragging a crusty, fish-tailing old boat behind, pushing a huge bug screen in front



and carrying, overhead, what appears to be next year's entire work load for the Goodwill Industries . . . at the wheel, a wild-eyed nut with at least one loose screw, a skaggy old bag and half a dozen sticky fingered, rock throwing kids with lollipops stuck in their ears and a howling mongrel dog slowly being strangled by 127 feet of 'Discover America' banners . . . they steam roll over stop signs, traffic lights, back yard fences, dogs, cows, kids, pedestrians, historical monuments and especially other mobile pig-sties. (Quite

often they are fired on by irate New Hampshirites and occasionally even by the Welcome Wagon.) All this in search of a pool of stagnant water (even a backed up septic tank will suffice) in which to launch their 22 foot boat (?) with twin 50 hp motors, an antique shop from which to buy a piece of driftwood, a broken rocking chair, a two legged buffalo milking stool, some genuine Indian artifacts (made in Hong Kong) or a hand painted lobster claw with 'Souvenir of Kankgamangus by the Salt Flats' painted on it, or to find some picnic/rest area where they divest themselves of a year's accumulation of HoJo cups, napkins, straws, half eaten Texas-burgers, glad bags and other assorted garbage.

The contamination record (presently held by a family of four) is 2 minutes 19 seconds to turn a picturesque rest area into a mess that has all the charm and beauty of a blighted and deserted land fill project.

Fortunately, however, I was saved from exposing myself to this danger when I was suddenly blocked by a taxi which pulled up in front of me. The driver, noting my garb and hearing my mumbles, quipped, "Need a lift to Foam Rubber City, Buddy?"



I sped around the cab to the driver's side, reached in, grabbed the driver by both lapels, shook and twisted and shook some more while screaming hysterically, "What's your name, What's your name? Just what the hell is your ruddy name?"

"Lillian! Lillian!" she gagged, "What's yours?"

"It's Bob," I replied, "No, it's Don—no, it's Howie—no, it's Herschel—I dunno—maybe it's Lillian."

She swung her dashboard mike like a bolo, catching both my hands and causing my thumbs to become jammed, one in each ear like deer horns (if it had been winter, I'd have been gunned down by a leaky booted Massachusetts hunter carrying a modified bazooka firing 88mm flare rockets). As she careened round the corner, and out of sight, I had the final satisfaction of seeing her hair turn white.

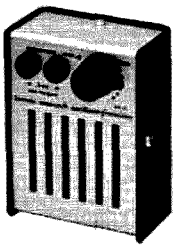
If you're reading this, I'm assuming two things not necessarily in evidence: One, that you have some sort of interest in radio and aren't just an itinerant kleptomaniac that absentmindedly scooped up this magazine as part of your daily quota and, two, that you know what a 'handle' is.

A 'handle,' besides being the mechanical accoutrement for lifting a pot, teacup, or thunderjug, is also, for some inexplicable reason, the coloquial idiom used in amateur radio by the Neanderthal ham in-group as a synonym for the name, 'name'; i.e. 'handle' replaces the name, 'name.'

The apprentice/greenhorn ham (or 'tongue-tied jerk' as he is ofttimes unfairly referred to) just breaking in and, not wishing to sound like an idiot, which incidently, is practically an impossibility on today's bands—it has long been my contention that you could recite any arbitrary exerpt from such books as, "The Orthopedic Surgeon Looks At Your Mattress," "The Abnormal Sex Life of the African Tse Tse Fly" or the prologue to "The Cause and Effect of Rampant Fungus on the Yucatan Peninsula" backwards, in Sanskirt or Pig-Latin and no one would think it strange, probably replying, "Roger O.M. Fine Business—I agree—I got a doublet here fed by 600 ohm twin line etc, etc., C.U.L. . .anyway, not wishing to sound like an idiot, the apprentice invariably slips into the 'dead sea scroll' word, 'handle.'

However, the younger generation—as it gains confidence and wishing to show its individuality and create its own neo-radiophyte in-group—has started a crusade to substitute the word 'name' for the word 'handle' which, of course, means 'name.' Consequently, if you wish to be of the modern in-group, you'd say, "My name is Bob!" Translated into Cro-Magnon ham lingo, this would mean, "My 'handle' is

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Bob!", which, translated into English, would mean, "My name is Bob!"

Logically, it should follow that when you say, "My name is Bob," you in reality mean, "My name is Bob!" but this, by antiquated League standards, is not only totally ridiculuous and ludicrous, but downright sacrilegious! (This transgression may be forgiven if you immediately yell, "Hail Huntoon et tu Hart" ten times while ingesting the first fifty pages of the Handbook, having "I LOVE I.C." tatooed on both pectoral muscles, or goosing a non-League member with a hot soldering iron.)

I might also add that the younger—or upstart—generation, as a further impiety, is attempting to do away with speaking CW phrases on the phone bands . . . damned kids. The CW advocate when switching to voice retains a lot of the CW colloquialisms such as "Q" signals. Ever try to talk in "Q" signals? At best it's like trying to pronounce pharmaceutical conglomerations while sucking three jaw breakers underwater with a split palate.

You can get away with 'cue-so' for QSO and 'Q Street' for QST and Quirt for QRT, but you're gonna rupture your larynx pronouncing QRP, QRO, QRV, QSL and QTH (Quith?).

The opening dialogue may have sounded unreal, but tune across 75 meters any evening and ye shall find the truth.

I've been net control on many occasions when there were four Bob's, five Don's, two Bill's, two Walter's, three Howie's and two Ed's. Occasionally, however, you'll run across a Vladamir or a Katrina to break the monotony and keep you from turning 23-year-old female taxi drivers into white-haired old ladies on a daily basis.

[Funny my mentioning Katrina. Poor ole Katrina—she recently ran amuck when some good intentioned neighbor, thinking that the name 'ham' applied to the male of the species only, called in an ITVI complaint and called her a 'sow.' Katrina took immediate affront to this, cornered the caller and



force fed him a mixture of 2 pints of milk of magnesia and 1 pint of vodka (the world's second largest Phillips Screwdriver).

Katrina was brought to trial, convicted and sentenced. Now, I don't know your feelings about capital punishment—in this State the maximum penalty is hanging—but, by golly, I just don't believe a woman should be hung like a man!]

Since the age span of any arbitrary group of clustered hams may range in years from 20 to 70, it is, indeed, a weird phenomenon that you'll find a sickening repetitive duplication of names. It gives one pause to wonder if, by some E.S.P. or precognition on the part of the parents that their offspring would end up being hams, they, through either a singular lack of imagination, some secret sense of humor, bestowed a seemingly endless string of common, lackluster names on all hams and hams to be.

If you were to recognize any ham by his upraised joystick or slipstick or notice him mounting his hustler, accost him and ask him—point blank—what is *the* most single important item in his shack, he'd like as not

reply, "The receiver, or possibly the antenna." This is a malicious rumor spread by the same group that sponsored Edsels, slipped amateur radio the purple shaft with oatmeal clusters by turning 50% of the ham bands into a vast wasteland, and that is trying to give 10 meters to the CB'ers.

Let me assure you with a conviction born of frustration (mental constipation) that the most important item in your shack is your name and you will be saddled forevermore with the first name you give on the air.

If you've been cursed with a common name, then by all means adopt a *nom de plume* (pen name, for you illiterates).

Selecting the proper 'on-the-air name' should not be handled lightly. Television—especially late night movies—offers the most versatile virgin land for procuring a name.

Horror: Bela, Boris, Igor, Krag, Zandor, Mandrake, Luthor, Kral.

Cowboy: Wyatt, Duke, Matt, Knobby, Windy, Bat, Tex, Bret, Bart.

Ancient: Mars, Herc, Eros, Ajax, Thoth, Vulcan, Cronos, Thor.

War: Sarge, Gunner, Chief, Buck, Cap'n, Doc, Tex.

Misc: Kelly, Sully, Murph, Tab, Ty, Rip, Dash, Rock, Torn, Sue (?).

Just remember that, in real life, every Tom, Dick and Harry is named Tom, Dick and Harry, but in ham radio I've found that every Tom, Dick and Harry is named "Bob!"

One word of caution. Don't get too cute or you could end up like this:

"Name here is Spiro T."

"Spell it!"

"Spiro T—Sierra Papa India. . ."

"Whazzat last?"

"India—India November Delta. . ."

"Whazzat last?"

"Delta—Delta Echo Lima Tango. . ."

"Whazzat last?"

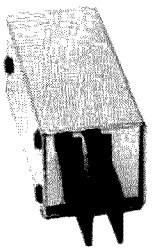
"Hell, I dunno—what am I spelling anyway? Who am I? What's my name? What's my name? It's Bob, no, Spiro T. I'm number one—you're Don, Quirt Quirt cue-ess-why Quirt WWAAAA—HOOOOOOO! Run for the hills, Lillian, HERE I COME AGAIN. . . GERONIMOOOOOO!!!"

"Look out for that guy wire!"

"What guy wiiiAAAWWWKKK??"

. . . K1YSD ■

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THE DIP LIGHT

Have you ever wondered how the grid dip meter got its name? I think it is self-explanatory to a certain extent, indicating that there is a meter in the grid circuit of a tube and that it measures the dip in current that occurs as the energy is absorbed when the oscillator tunes to the same frequency as the circuit under test. The name is all right as long as you think in terms of the tube circuit, but in recent years we have been seeing circuits using transistors and tunnel diode oscillators taking over. In other words, no grids.

So now the name has changed to "dip meter," which is fine as long as you have no objection to the meter part. As I see it, the meter has done a very good job in the past on this instrument, but nowadays we can come up with devices not limited by the constraints imposed on the people who first developed the grid dip meter. Think of a pilot light bulb, for instance. How much better it would serve the purpose, since you would not have to concentrate on it to see a dip as you would with the meter. Many times as I stared at the meter (which happens to be at the opposite end from the coil), I would find that I was getting no dip simply because I had inadvertently moved the coil away from the circuit under test.

A light bulb is much more obvious than a meter needle, and in this use you really would not need the precision that a microammeter gives. All you really want is a dip. A light bulb is just not sensitive enough to read microamperes. But what if you were to help it with a couple of transistors? This is the crux of the dip light shown in **Fig. 1**—the little devil that will do everything that a grid dip meter will do, only better. And it can be built more cheaply, to boot.

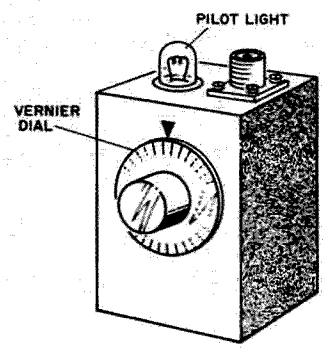


Fig. 1. A vernier dial on the front of the unit can be calibrated without much difficulty. The bulb itself can be held in place by cementing it to an ordinary grommet.

Construction

You can use regular coax connectors for the coils and build the latter on a stub of coax about 3 in. long, with the connector at one end, the outer cover and shield peeled

back as shown in Fig. 2. The coil is wound on the plastic core, soldered to the center conductor and shield and then covered up with GE crude rubber cement, which is quite soft and flexible even after having cured.

The indicator lamp should go somewhere near the coil, where you can see it and the coil at the same time. For the frequency readout I used a small calibrated vernier drive. You'll find this easier than making

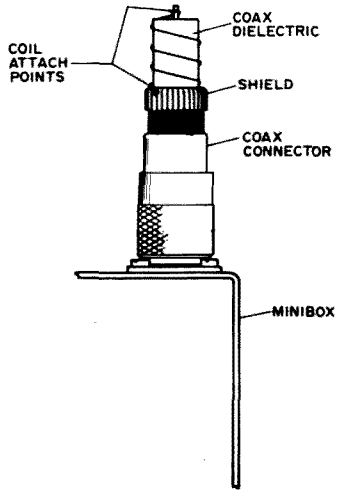


Fig. 2. Coils can be built onto bits of RG-8/U cable and terminated with UHF connector.

your own dial, and you can use a chart or set of curves to correlate frequency with the calibrated increments.

For the tuning capacitor, use an APC with a ¼ in. shaft. Mine had some plates removed, but I would guess it to be about 30 pF.

The oscillator circuit happens to be my pet one, but since it is not critical, you could use your own circuit. It occurred to me that one could open up one of those two-dollar modules sold as FM wireless instrument broadcasters. At least one that I know of is not encapsulated in epoxy. I built my own (Fig. 3) with GE9 transistors and have no trouble getting this little gem to oscillate up to 120 MHz.

Capacitor C1 should be chosen to oscillate down to the lowest frequency to be used. My unit worked well with a 55 pF capacitor. Resistor R1 should be 100 kΩ initially; then, when you have finished building you can replace this with a 0.5 MΩ temporarily, adjust this for a good indication on your lamp (I set mine for maximum rf, but don't know how good this might be for the transistor), and then replace with a fixed value to correspond with the setting of your pot. The lamp amplifier is a Darlington circuit to provide a better load for the diode circuit, but you could use a one-transistor circuit almost as effectively.

Be sure that you use high-gain transistors in either case though; they should be medium-power "driver" types to handle the current required to light the lamp, which should be a low-current one such as the 48 or 49 bulbs (coded with pink beads). Use two penlight cells for power and you end up having a really versatile instrument.

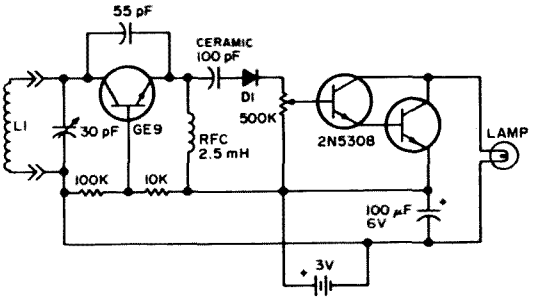


Fig. 3. Dipper is nothing more than a simple oscillator and a Darlington amplifier pair.

Plotting the Frequency

Making the frequency curves should be a simple enough matter using "science" graph paper and an accurately tuned receiver. Simply tune the receiver to the frequency that you need then find it with the frequency control of your dipper. First find the highest and lowest frequency that the instrument will cover, and mark this along the side of your graph. Mark the maximum number of divisions of your dial along the bottom of the graph. Then spot a few frequencies more or less evenly spaced between the maximum and minimum, and draw your curve to touch all the points. Voila! You have a curve for one coil. Repeat this for the others. This method is good because if you ever wish to make an extra coil, you simply make an extra frequency curve for it and do not have to alter your instrument at all.

. . . VE3ECU/WØ■

73 Checks Ont The KRIS Scanning Receiver

One of the most interesting technological innovations in recent ham radio history has been the "scanner"—a transistor FM receiver that has the capability of monitoring a multitude of crystal-controlled channels by sequentially scanning the frequencies at a high rate then stopping and "locking on" to a frequency where a signal is present.

The idea of scanning is not new; there were a number of military "autoscan" receivers in use during the second world war—but these were large and cumbersome, they used mechanical contrivances for slewing, and they tuned at a rate so slow that short-duration transmissions could take place without being spotted. Today, with more and more frequencies being "standardized" for repeater operation in the VHF bands, the scanning receiver takes on more the stature of a necessary part of a truly "mobile" mobile setup, and less that of a conversation piece.

In the New England area, for example, where repeaters stud the hilltops, a user who wants to get the optimum use from his equipment will have to be prepared to transmit and receive on as many as four repeater frequencies—in addition to those frequencies established as "point-to-point." The problems of monitoring for activity can become trying when you pass through areas where several repeaters—on different frequencies—are operational. I found myself monitoring 146.94 MHz for signs of action on the W1ALE repeater while the Mount Snow and Concord machines (146.88 and 146.76, respectively) were hopping. A scanning capability, I felt, would serve as a "funnel" and allow monitoring of all the repeaters and point-to-point channels at once.

So that I could check out the practicability of monitoring with a scanning receiver, I invited the manufacturer of the Kris scanner to lend me a unit for a while for test purposes. I had seen Kris' ads and was frankly impressed with the specifications. The people at Kris were accommodating, and provided a receiver that was tuned up, crystaled, and ready to go.

I was in for a few surprises when I opened the box. The ads I had seen on the Kris units had been for the "Snooper," a

$139 unit with an "automatic–manual" switch for mode selection. But what I received was the top of the line: a $149 receiver with a built-in switching capability that permits the operator to "lock out" any channels he does not wish to monitor. Also, I discovered that the unit is not restricted to mobile use; it comes with a built-in power supply to permit use from either 115V house current or the 12V power from a car battery. It also comes with a removable telescopic whip antenna that attaches through a grommeted hole in the cabinet top.

On the negative side, the regular antenna connector on the back of the scanner is made to accept the plug that comes standard on automobile BC radio antennas. This might be great for someone who wants to forego his mobile BC listening in favor of monitoring the local FM nets, but for most of the hams I know, it would be an annoyance. The ideal connector, in my estimation, would be a conventional UHF connector suitable for matching with regular RG-8 or RG-58/U coax. It is probably safe to assume that the unit was originally developed for use by off-duty civil employees and other nontechnical people who would be stopped by so strange a beast as a PL-259 or its mate. At any rate, the required adapter is an Antenna Specialists M46; and the Kris people indicated they would supply the adapter if the request is made at the time of order.

Operationally, the Kris scanner is a wonder. It sits there silently and does exactly what it was made to do–quickly, efficiently, and rhythmically. The receiver scans at the rate of 20 samples per second, so that each channel (there are seven of them) gets "visited" every 0.3 second. The scanning rate remains the same whether some channels are skipped (locked out) or not. Each of the seven channels has a numbered indicator lamp that glows during each "sample-taking" period. When a signal appears and the receiver locks on, the lamp for that channel stays on so the operator can identify the active channel.

I checked the unit out in the 73 Magazine office where the sophisticated test equipment complement consists of a volt-ohmmeter and a pair of pliers–so there was little in the way of measurements that could be done. But I did have a receiver of known sensitivity for comparison, and all indications were that the Kris performed in consonance with the manufacturer's specs; signals that quieted the known receiver by 20 dB did the same on the Kris scanner. Since the "control" receiver was rated for a sensitivity of 0.5 μV for the 20 dB quieting factor, it is safe to assume that Kris' specs (identical to those for the control receiver) are accurate.

With respect to bandwidth, it should be noted that the Kris is a "good" receiver–and, like any good receiver, it is reasonably selective. But a highly selective receiver can't have a broad bandwidth without some compromise. Thus, the Kris scanner should be tuned for the frequency in the center of its range. The performance tends to degrade gradually off either side of the center frequency of interest. Since the degradation is insignificant over a range of several megahertz, this little tidbit of information will be inapplicable to most users. But if you plan on monitoring the local repeaters as well as the police frequencies in the 155 MHz region, try to plan your channels so that the top frequency is no more than 8–10 MHz from the lowest frequency of interest. And even then you'll have to compromise the sensitivity on the low end if you want acceptable performance on the top. For the conventional repeater frequencies, however–between 146 and 148 MHz–you'll find no deterioration in performance over the whole range.

All things considered, I think the scanning receiver will find a home with the FM crowd. Even if you don't have a lot of active channels in your area, it's always nice to monitor the more popular frequencies for transient mobiles, DX, or blossoming FM activity. The scanner is really great . . . easy to get used to . . . easy to get dependent upon. But what I can't figure is why nobody has ever made a scanning transceiver?

. . .K6MVH ■

TWO CONVERSIONS FOR THE MOTOROLA 41V

PART 1: AC POWER SUPPLY

Jim Romelfanger K9PKQ
117½ 4th Street
Baraboo WI 53913

This power supply was designed to provide the voltages necessary to operate the 41V Motorola mobile as a base station. The idea behind the supply was to make it possible to convert a unit for ac operation without removing any parts necessary for dc use. This adds considerably to the utility of the unit. An operator can use it at home on ac, but when he wishes, he can reinstall it as a mobile by the simple addition of a jumper plug.

The supply uses a common TV transformer in a full-wave circuit to provide a B+ potential of 325 to 350V, and a divider network for the low B+ stages of the rig. You may have to adjust the divider resistor values to come up with the exact values of low B+ called for.

The relays are supplied by a small filament transformer and a full-wave bridge rectifier. The diodes here can be most anything over a 500 mA rating and 100 PIV or better.

Please note that the diagram shows a supply for a 12V dc rig. If your rig is for 6V, either convert it for 12V or be sure to use a 6V relay supply transformer, and use only one 6V winding on the power transformer (the heaviest, of course).

With this conversion, control connections are made through the normally used 19-pin connector on the front panel. If the rig is a front-mount unit, you are really in business.

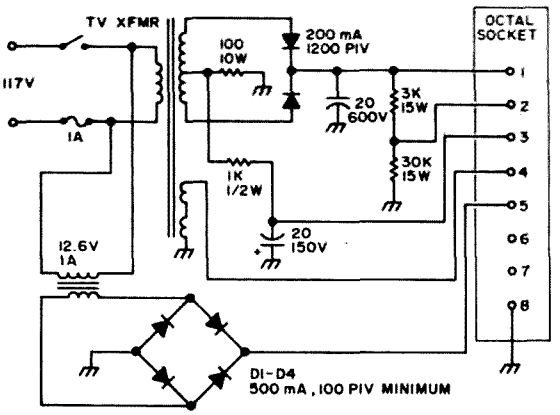


Fig. 1. Ac power supply for Motorola FMTRU-41V. (Original supply is shown in companion article.)

Step-by-step modification:

1. Remove RED lead from C10A and connect it to power socket pin 7.
2. Connect power socket pin 1 to C10A.
3. Connect power socket pin 2 to C9A.
4. Connect power socket pin 3 to terminal 10 on transmitter power supply strip.
5. Connect power socket pin 8 to ground.
6. Remove yellow lead from fuseholder and reconnect it to power connector pin 6.
7. Connect power socket pin 4 to fuse.
8. Remove relay lead from pin 2 of driver tube (2E26) and run to power socket pin 5. This step is for 12V units only.

Table I. Power plug connections.

Pin	Voltage	Current	Mode	Notes
1	350	150 mA	transmit	
2	200	55 mA	receive	
	150	50 mA	transmit	
3	-20		transmit	Bias
4	12.6 ac			6.3V ac in 6V equipment
5	12 dc			Relay supply
6	N/C			
7	N/C			
8	Gnd			

NOTE

If the unit being converted is a 6V model, change step 8 as follows: Remove the lead between E2-9 (transmitter supply tie strip) and K1-9/K1-10 (relay). Connect K1-9/K1-10 to power socket pin 5. Supply filament voltage to pin 6

The octal chassis connector plug is mounted on a small aluminum plate on the metal extension above the 19-pin control connector (top side of the power supply chassis).

Note that there is very little filtering in the ac supply. The capacitance in the rig has been found to be adequate to take care of ripple. It is possible, however, that the filters in the unit may have deteriorated and lost some of their ability to filter. In that case, replace 'em. Many units of this type have been subjected to considerable heat, which is rough on electrolytics.

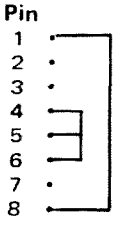


Fig. 2. DC jumper plug wiring.

The jump plug for dc operation can be wired up and then tied to the rig with lacing cord. Then it's there when you want it. Jumper wiring is shown in the shcematic.

. . .K9PKQ ■

PART 2: 6 TO 12V FILAMENT CONVERSION

Donald L. Milbury W6YAN
Box 463
W. Covina CA

Setting up the 41V to operate on two meters is too simple to warrant a complete article on the subject. After a few preliminary value adjustments, the tuneup procedure is perfectly straightforward. This article deals primarily with changing a 6V unit to 12V; but, in the interest of completeness, here is the frequency conversion information:

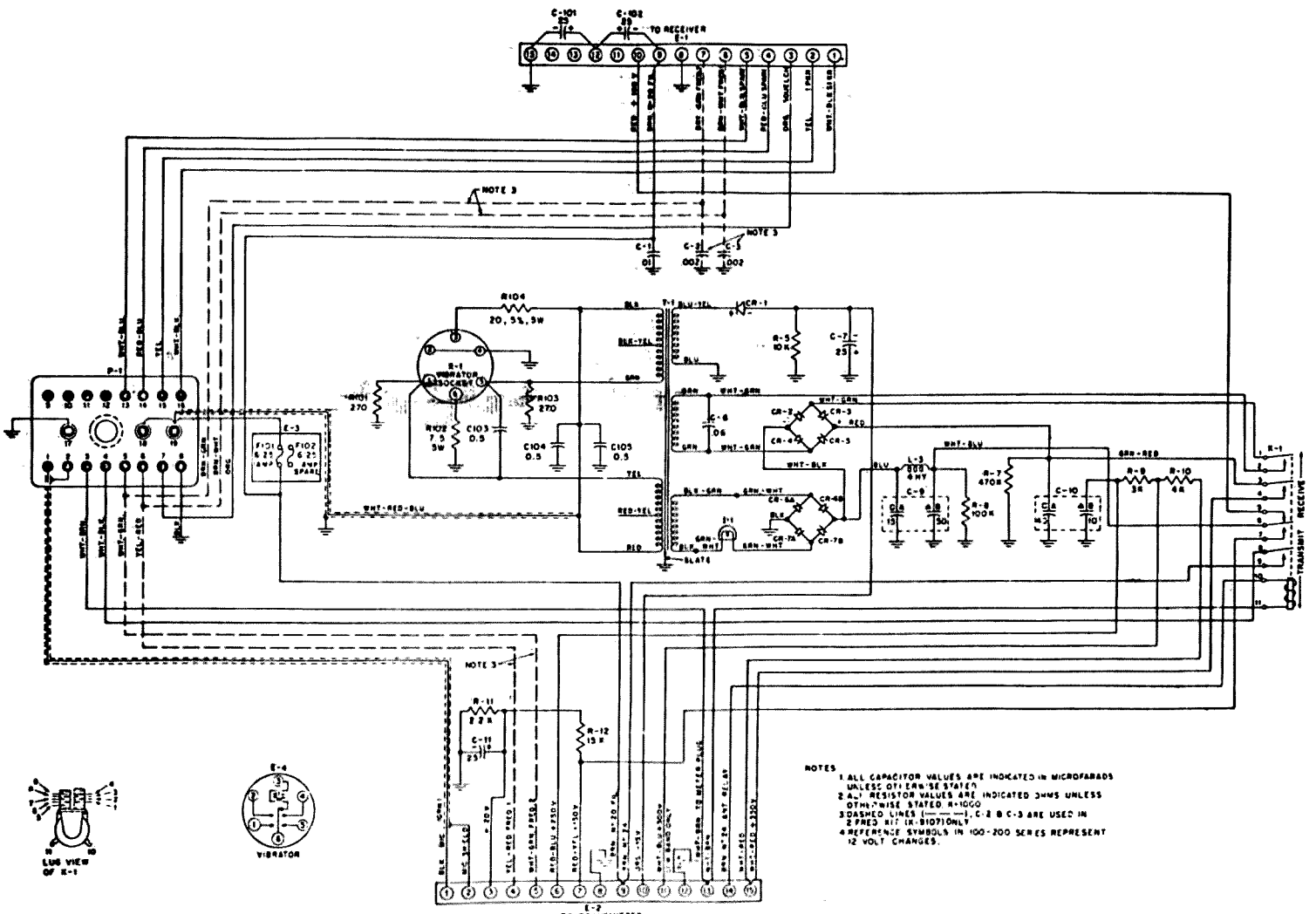
1. Add 2-5 pF from pin 1 to pin 3 on L1, L2, L3, L4, and L5 of receiver.
2. Add 4 or 5 pF from pin 1 to pin 3 on L7, L7A, and L8 of receiver.

Crystal data:

Transmit – Motorola Type R09, 85°C oven. Specify operating frequency; Sentry will correlate.

Receive – Most common is Motorola Type R21 (85°C oven). Specify operating frequency; Sentry will correlate.

Sentry address is: Crystal Park, Chickasha OK 73018.



41V POWER SUPPLY AFTER MODIFICATION TO 12 VOLTS

6 to 12V Conversion Transmitter

a. Doubler driver (V106)
   (1) Disconnect and remove the jumper between pins 7 and 8.
   (2) Disconnect the brown-white lead from pin 2 and connect it to pin 7. This connects tubes V106 and V107 in series.

b. Tube V105: 3rd doubler (25–50 MHz) 2nd doubler (152–174 MHz)
   (1) Disconnect and remove the ground lead from pin 3.
   (2) Disconnect and remove the jumper between pins 2 and 3.
   (3) Connect a jumper between pin 2 and the center shield (gnd).
   (4) Disconnect the brown-white to pin 3. This connects tubes V101 and V105 in series.

c. Audio Amplifier (V108)
   (1) Disconnect and remove the ground lead from pin 9.
   (2) Remove the jumper between pin 9 and the center shield.
   (3) Connect a jumper between the center shield and ground.
   (4) At the V108 tube socket, disconnect the brown lead (running from tube V109) from pin 4 or pin 5, depending upon which is used, and connect it to pin 9. This connects tubes V108 and V109 in series.

d. Tubes V102 (modulator), V103 (buffer and 1st doubler), and V104 (2nd doubler – 25 to 50 MHz tripler – 152 to 174 MHz

   Replace the three 6AU6 tubes (V102, V103, and V104) with 12AU6 types.

e. Antenna Relay
   (1) Remove the three screws that hold the antenna relay cover to the chassis. Unsolder the relay cover from the shield around the rf section.
   (2) Remove the solid bus which connects the relay coil to ground.
   (3) Connect the brown-white lead between the relay coil lug, from which the ground bus was just removed, and pin 2 of tube 106.
   (4) Replace the antenna relay assembly on the chassis by means of the three screws. Resolder the relay cover to the rf shield. This connects the relay in series with the transmit-receive relay on the power supply chassis.

f. Crystal Socket (Single-Frequency Models)
   (1) Mount two 15Ω resistors near the crystal socket by using existing holes in the chassis. Place one lockwasher, one eyelet, and one fiber washer at each end of the resistor. Connect the resistors in parallel.
   (2) Disconnect and remove the ground connection from the crystal socket.
   (3) Connect one end of the paralleled 15Ω resistors to the crystal socket terminal from which the ground connection was just removed.
   (4) Connect the other end of the paralleled resistors to ground.

g. No. 2 Oscillator V201 (two-frequency models only)
   (1) Disconnect and remove the jumper between pins 2 and 3 of the V201 tube socket.
   (2) Connect a 39Ω resistor between pin 3 of tube V201 and the grounded lug on the crystal socket (X202). This connects the filament of tube V201 in series with the 39Ω resistor across the 12V source.

h. Crystal Assemblies (two-frequency models only)
   (1) Make a note of the frequency of each crystal and remove the two crystal assemblies from their sockets. The crystals must be removed from each 6V assembly and inserted in the new heater and base assembly as outlined in the following steps. Use care so that 6 and 12V assemblies are not mixed.
   (2) Remove the housing cover by releasing the ring clamp.
   (3) Remove crystal from the 6V base

(continued on page 93)

A CW MONITOR

How to get a 98¢ oscillator module to key on and off with your rf

J. A. Houser WB2GQY
23 Washington Street
Rensselear NY 12144

It seems that selfishness, next to greed, is the greatest incentive to invention – to want some device to accomplish some desire; and when such is not available, the selfish man will create it, if possible.

I found myself in this position with regard to a desire to be able to monitor my CW transmissions on any band – *without* touching the monitor other than to turn it on when required and shut it off when not, without any connections whatsoever to the transmitter, as I detest modifications of equipment.

After scanning handbooks and catalogs, I could find nothing like what I wanted, so I decided I would just have to build one. I felt this could not possibly be a complicated device. Live and learn!

The untunable, nonresonant quality I wanted appeared perhaps to be the most insurmountable obstacle. Transistors seemed to be the most feasible devices to use in view of the fact that self-power was also an objective.

Did you ever try to pick out a particular transistor for a particular application – with the thousands, nay, maybe tens of thousands of transistors to choose from? If you did, perhaps you might do as I did – use what you have! Somehow, you always seem to find something that will work.

But to get on with the project: Of necessity, you have to have an audio oscillator and a speaker. I saw a cheap audio oscillator module in the Lafayette catalog for 98 cents and I figured I couldn't make one for less, so I bought that along with a small steel-encased speaker with a universal bracket (see parts list). This module is designed to work with anything from 1.5 to 6V, but 3V is recommended. One of those battery holders which hold two size D flashlight cells side-by-side seemed ideal for the power. Everything was swell so far; it worked well, with two pieces of hookup wire for the key, as I didn't intend to key it anyhow. An instruction sheet came with the module showing hookup. The note is about 1 kHz with 3V applied.

Now the sticky part of the design started to erupt. You have to have something to switch the module on and off with the CW signal. Seemed like a power-type transistor should work, but how much power? What current does the module draw from 3V? Nothing like measuring it – here is the result:

V	mA	R (load)	W
1.5	19	75	0.030
3.0	32	93	0.096
4.5	38	119	0.18
6.0	45	133	0.27

So you will need a transistor that will handle 96 mW, and this eliminates any of the small audio output transistors such as

used in the little BC radio receivers, because most of them put out only about 20 mW. An audio power output transistor such as used in the auto radios will handle 100 to 200 mW, so it is ideal. Since I just happened to have one of these on hand, I hooked it up as in Fig. 1 to find out what control voltage I would need to fire it.

Now I had to decide whether to do a lot of research to determine whether all the parameters were correct or whether just to hook it up and see if it worked. I decided on the latter. I hooked it up per Fig. 1 and started with 1.5V between X and Y, then 3.0, then 4.5 and 6V. Finally, with 9V, it fired, and the audio oscillator switched on. Now I was almost certain I could not get 9V dc out of rf rectified from a small whip antenna to fire this directly, so I figured I would have to put another control switch (transistor) ahead of this one to control the 9V needed to switch it on. Perhaps I could pick one out that would take about 1.0 to 1.5V dc from rectified rf to switch it on and off – sort of a double switch, if you will.

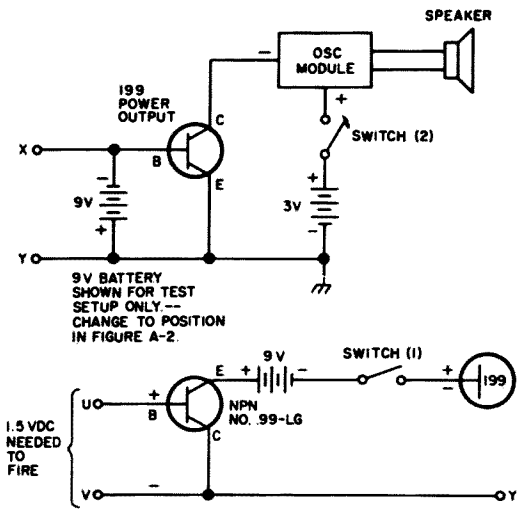


Fig. 1. Test setup. 9V battery is used in test only. Change to position shown in Fig. 1B.

I just happened to have another audio driver and output transistor such as used in miniature BC receivers on hand, so I tried this. It was an NPN type. I hooked it up ahead of the power transistor to see what voltage dc I would need to fire it, which would then fire the power transistor, which would then turn on (and off) the audio oscillator module. I found I needed 1.5V at the base to fire this one. It fired the power transistor, which turned on the audio oscillator, and I got a fine 1 kHz note. Everything so far was fine.

Now all I needed was 1.5V dc from rectified rf, and everything would be cooking. I tried a single IN34 diode hooked to a piece of hookup wire for an antenna, and the best dc I could get from this arrangement was about 0.3V.

Well, why not an rf voltage doubler? After all, these work at 60 Hz and are used in many receivers and some low-power transmitters. So I hooked up a voltage doubler as in Fig. 2.

Sure enough, up went the rectified dc voltage. In the 40 meter band it even went as high as 12.0V dc; and in the 80 meter band it was about 1.8 to 2.5V dc, which should be more than enough. However, in the 20, 15, and 10 meter bands, I could get only about 0.3 to 0.9V, which would not fire the first control transistor.

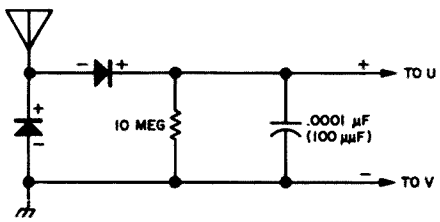


Fig. 2. Voltage doubler rf pickup. 1N34s.

I thought maybe I could improve the antenna pickup to acquire the additional voltage required. I tried all kinds of loops, from 1 turn to 100 turns, figuring the electromagnetic pickup might be predominant over the electrostatic pickup from a unipole antenna, only to find out that no loop at all would work. The pickup just has to be from a unipole! Then I tried a counterpoise along with the antenna, figuring I might end up with a pair of rabbit ears. Nothing except a single unipole would work. I had been working with GE IN34 AS type germanium diodes, so decided to try some surplus ones removed from old IBM computers. All seemed to work about the same,

PROPAGATION CHART

J. H. Nelson

Good O Fair (open) Poor □

March 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
(1)	(2)	(3)	(4)	5	6	(7)
(8)	(9)	(10)	(11)	(12)	(13)	(14)
(15)	16	[17]	18	(19)	(20)	(21)
(22)	(23)	[24]	25	26	27	[28]
29	30	31				

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7B	14	21	21	21
ARGENTINA	21	14	14	14	7	7	14A	21	21	21	21	21
AUSTRALIA	21	14	7A	7B	7B	7B	7B	14B	14	14	21	21
CANAL ZONE	21	14	7A	7	7	7	14	21	21A	21A	21	21
ENGLAND	7	7	7	7	7	7B	14	21	21	21	14	14
HAWAII	21	14	14	7B	7	7	7	7B	14	21	21A	21A
INDIA	7	7	7B	7B	7B	7B	14	21	14	7B	7B	7
JAPAN	14	14	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO	21	14	14	7	7	7	7	14A	21	21	21	21
PHILIPPINES	14	14	7B	7B	7B	7B	7B	14B	14B	7B	7B	7B
PUERTO RICO	14	7A	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	7A	7A	7	7B	14	21	21A	21	21	21	21
U. S. S. R.	7	7	7	7	7	7B	14	21	21	14	7B	7B
WEST COAST	21	14	14	7	7	7	7	14	21	21	21A	21

CENTRAL UNITED STATES TO:

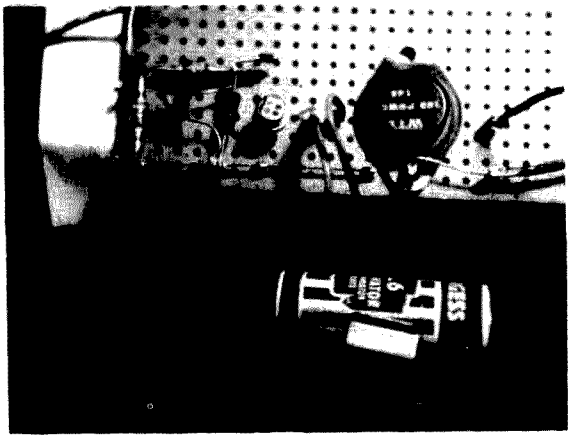
ALASKA	21	21	14	7	7	7	7	7	14	21	21	21
ARGENTINA	21	14	14	14	7A	7	14	21	21	21	21	21
AUSTRALIA	21A	21	14	7A	7B	7B	7B	7A	14	14	21	21
CANAL ZONE	21	14	14	7	7	7	14	21	21A	21A	21	21
ENGLAND	7B	7	7	7	7	7	7B	14	21	21	14	14
HAWAII	21A	21	14	7A	7	7	7	7	14	21	21A	21A
INDIA	7B	14	14	7B	7B	7B	7B	14	14	7B	7B	7B
JAPAN	21	21	14	7B	7	7	7	7	7	7B	7B	14A
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14	7B	7B	7B	7B	7	14B	7B	7B	14
PUERTO RICO	21	14	7A	7	7	7	14	21	21	21A	21	21
SOUTH AFRICA	14	14	7A	7	7B	7B	14	21	21A	21	21	21
U. S. S. R.	7	7	7	7	7	7B	7B	14	14	14	7B	7B

WESTERN UNITED STATES TO:

ALASKA	21	21	14	7	3A	7	7	3A	7	14	21	21
ARGENTINA	21	21	14	14	7A	7	7B	14	21	21	21	21
AUSTRALIA	21A	21A	21	14	7	7	7	7	14	14	21	21
CANAL ZONE	21	21	14	7A	7	7	7	14	21A	21A	21A	21
ENGLAND	7B	7B	7	7	7	7	7B	7B	14	21	14	7A
HAWAII	21A	21A	21	14	7	7	7	7	14	21	21A	21A
INDIA	7B	14A	14	7B	7B	7B	7B	7	7	7	7B	7B
JAPAN	21A	21	14	7B	7	7	7	7	7	7	7B	14A
MEXICO	21	14A	14	7	7	7	7	14	21	21	21	21
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7	7	7B	7B	14
PUERTO RICO	21	14	14	7	7	7	7	14	21	21A	21	21
SOUTH AFRICA	14	14	7	7	7B	7B	7B	14	21	21	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14	14	7B	7B
EAST COAST	21	14	14	7	7	7	7	14	21	21	21A	21

A - next higher frequency may be useful
B - difficult circuit this period

and I could not get the rectified dc higher on the higher frequency bands. Next I minia-



Monitor can be set up simply on a piece of perforated board. It's a lot easier than a PC board.

turized the breadboard layout. Nothing changed, and now it was small enough to put into the speaker case on one side, with the code oscillator module on the other side, and the antenna coming out the top.

So I now have a nice little miniature CW monitor on 80 and 40, which are the two bands I work CW on most. Anyone who wants to use this on 20, 15, or 10 may, with a little more research and development, get it to work on the higher bands.

Here is the parts list with approximate prices:

- 2 diode rectifiers, GE 1N34AS or equivalent ($1.50)
- 1 pkg. (100) T-28 terminals, Laf. 19-8302 ($1.55)
- 1 P91 terminal inserter, Laf. 19-8306 ($.50)
- 1 2" x 4" PC Vector, phenolic punched board–for no. 28 terms. ($.25)
- 1 3" speaker and case, Laf. 44-5201 ($6.45)
- 1 9V battery holder–Keystone 173 ($.35)
- 1 Cordover solid state oscillator module, Model CPO-4, Laf. 19-1513 ($.98)
- 1 Workman TV transistor NPN, 99-L6, audio output ($1.00)
- 1 Workman TV transistor, power, WTV-199-140 ($1.50)
- 1 100 pF capacitor ($.15)
- 1 5 meg ¼W resistor ($.12)
- 1 old antenna rod from TV rabbit ears or old auto antenna
- 1 5/16" rubber grommet
- 1 9V transistor battery
- 2 1½V D flashlight batteries; hookup wire, solder, etc. as required
- 1 DPST slide switch ($.35)

. . . WB2GQY ■

The Logical Approach to Surplus Buying

Jim Kyle

All that's surplus is not military . . . or FM.

Take a look at the surplus ads in this issue—and you may be a bit surprised by what is turning up on the market these days.

For instance, a random sampling of a recent issue shows one ad featuring a "6,400 memory drum," faced by another which offers "brand new RTL integrated circuits." Elsewhere in the same issue we find "universal logic circuit cards," and a potpourri of "dual 4-input *nand* gate," "quad 2-input *nand* gate," and "J/K flip-flop master slave" IC chips. That's all a far cry from the decoherer, spark gap, and Alexanderson alternator—or even from the push-pull 304TL's or war-weary ART-13's which used to be the mainstay of the surplus market.

It's probably an insult to most of you to assume that you don't know that all these strange new items in surplus come not from military communications channels, but from the computer industry— and so it won't be assumed.

But the question just may remain open, as to what earthly (or spacely, either, for that matter) use such gadgets could be in ham radio. And the purpose of this parcel of prose is to attempt to provide a route toward finding some answers to that question.

Now that we have assumed that everybody knows these strange things come from the computer industry, we'll be a bit more specific and point out that it's the *digital* computer industry which provides most of the goodies. Analog computers are still with us, and will be for a long long time because for some purposes, they're better machines—but the big money, and the big market, is for digital computers, and Detroit has nothing on the computer sciences. After all, if you buy a new car you can expect it to

run for at least three years, and maybe even until it's paid for—but the average life of a large-scale computer system is more like two and a half years. By that time, the state of the art has advanced so far that your "brand-new" machine is obsolete.

This rapid obsolescence cycle is what's putting so much computer surplus onto the market now. While most hams are still a bit puzzled by the whole idea of integrated circuits (sort of like we were by transistors way back in 1959 and 1960), the computer people have moved through two whole "families" of IC designs and are now well into the third generation. The obsolete stuff has to go somewhere, and that's where the "surplus" comes from.

"Fine," you may be saying, "but I don't want to build a computer. What good is this stuff to me?"

Patience. It may turn out to be a gold mine for you. And it may not. Only you can decide that, but in the pages which follow we're going to try to give you enough information to let you make the decision, and to let you use these things for purposes their original designers never had in mind.

Logic Elements

Right here at the outset it would probably be a good idea to define some of the words and phrases used in the computer industry for these circuits, because the ads cited earlier reveal some lack of understanding—and when the sellers are mixed up, then the buyer who knows what the words mean has a chance to get even better bargains than usual.

Computer designers tend to think in terms of *logic elements*, which can best be thought of as little black boxes which do one and only one job. The most common types of logic elements are flip-flops, gates, and a third type variously called a buffer, a driver, an amplifier, or sometimes an inverter.

Flip-flops are logic elements which have at least one and sometimes as many as four input terminals, and usually two output terminals. The signals at the input terminals determine the "state" of the flip-flop, but once the state has been either "set" or "cleared," the input signals can be removed and the output terminals will continue to indicate the state without change. The major purpose of a flip-flop is to "remember" a transient signal level or condition; several flip-flops, of some special subtypes, are often connected in cascade one after the other to serve as a counting circuit.

Gates are logic elements which have two or more input terminals, and usually a single output terminal. The presence or absence of signals at the input terminals, and especially the combinations of signal levels simultaneously present at all input terminals, determine the signal at the output terminal. Gates have no memory capability; when the input signals change, the output signals change also.

The third class consists of logic elements which normally have only one input terminal and one output terminal. The names buffer, driver, and amplifier mean the same in the computer world as they do in ham radio. This logic element provides isolation between more active stages in a design, and also helps provide driving power (because digital-circuit input terminals represent fairly heavy loads upon their driving circuits). The inverter is a special subclass of this type of circuit, which produces an output signal of opposite value to its input signal.

We'll go into these types of logic elements in more detail a little later, but before we do there are several other terms which are not exactly everyday phrases in amateur radio—which are, still, important in understanding how these circuits work.

Digital circuits are, almost without exception, designed to operate with "binary" signals. A binary signal is one which can take on only one of two possible values. For instance, it may be a +2V level, or a ØV level, with respect to ground. In practice, the actual circuit will be built to interpret any voltage above some specific value as being the higher of the two levels, and any below that value as being the lower. This voltage level, which separates the *high* from the *low* binary signal value is known as the *threshold* of the circuit, and the exact voltage values which are the two values of the binary signal are known as the *logic levels*. Often, one of the logic levels is zero volts, and then only the other logic level is specified.

We mentioned a bit earlier that digital

circuit input terminals represent quite a load to their driving circuits. When we get to the actual schematics, you'll see why. Because of this, digital circuits are rated for *fan-in* and *fan-out*. The units used for rating fan-in and fan-out are usually arbitrary. One type of gate, for instance, might represent a 2-unit load and be rated for a fan-in of 7 and a fan-out of 12.

This would mean that such a gate could accept at any one of its inputs, then, connections to three identical gates, and could drive from its own output terminal six other gates.

If more than 6 gates need to be driven to make the circuit do what the designer intended, he would have to add a buffer as one of the loads on this gate. The buffer might represent a 3-unit load, and that would leave only 9 units of fan-out available so that only 4 other gates and the buffer could be connected.

The fan-in and fan-out ratings are meaningless unless you know the number of units of load represented by each logic element you want to include in a circuit, but they still give you an idea of the relative power output of different elements in the same family. The higher the fan-out rating, the more power is available at the output terminal.

The Logic of Switches

Before we can make much practical use of the digital circuits available in surplus, we need to know how the circuits work. And to do that, we must know a bit about electronic logic circuits. Fortunately, it's not very complicated. What makes a computer circuit so complex is not the individual circuits– each circuit is about as complicated as a diode detector, and far less difficult to understand than an audio amplifier – but the vast numbers of them involved, and the hundreds of feet of interconnecting wiring hooking them all together.

You can't get much less complicated than a simple switch – but that's just what the basic digital logic circuit amounts to. If the switch arm is in one position, current flows one way; if the switch arm is in the other position, the current flows to the other terminal. The "live" pole indicates the position of the switch –but we usually think of it in a different way, and believe that the position of the switch tells us which way the current's flowing.

This is fine if it's *us* who has to do the remembering, but in a computer it's the circuit which must remember something. And it may be overstating things to point out that the "up" or "down" position of the switch handle *does* remember for us what we did there last. This small fact is never fully appreciated until you work with equipment which uses "alternate action" switches which you push once to turn on, again to turn off, and after they're pushed you can't tell by looking whether they are on or off.

Let's take that SPDT switch and connect a couple of them to form a logic gate. **Figure 1** shows the circuit. Electricians among the readers may recognize this as the "three-way switch" circuit for turning a light either on or off from either of two locations, but it's a logic gate circuit as well, because the output signal (the fact that the light is one, or off) depends upon both input signals (the positions of each switch individually). If switch A is up and switch B is down, or vice versa, the lamp is off. If both switches are up, or both down, the lamp is on.

In logic, a *truth table* is often used to describe the actions of any logic element. **Figure 2** is a truth table describing the circuit of **Fig. 1**. The important thing to note here is that every possible one of the switch positions is included in the table, and the output condition for each of these possible input conditions is also included.

The truth table in **Fig. 2** uses words to describe the input and output conditions. Truth tables used to describe the functions of various logic circuits usually use either the initials **T** and **F**, for *true* and *false*, or, more often, the numerals **1** and **0**, to describe the two states of the signal level.

Remember that these circuits operate only with binary signals. If we name one logic level **1** and the other logic level **0**, we can then relate the actual voltages at the input and output terminals of any circuit to the **1** and **0** entries in the truth table for that circuit, and the truth table will tell us what output the circuit will produce for any possible combination of input signals.

To illustrate the point, **Fig. 3** is a redrawn

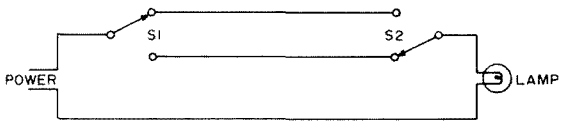


Fig. 1. This simple circuit, known to electricians as a three-way switch, for controlling a light from two separate locations, is also a rather exotic digital logic circuit. No gate used in digital logic is any more complex than this circuit, though it may have more control points.

Switch Positions		Lamp
S1	S2	
down	down	on
down	up	off
up	down	off
up	up	on

Fig. 2. Truth table describes all possible conditions of a three-way switch circuit. Left two columns show switch positions and right column shows lamp condition which results from each combination of switch positions. Systematic tabulation of switch positions insures that all possible combinations are included; positions for S2 alternate from down to up to down to up, changing at each line, while positions for S1 change only when a position of S2 is repeated. If the circuit had three switches, 8 lines would be necessary to describe all

version of **Fig. 1** with the switch positions labeled as **1** and **0**, and also includes the truth table in **1** and **0** terms. In this table, an output of **1** means the light is on, and a **0** output means the light is off.

If we think only of two-input gates, we could design circuits to fulfill any of 16 truth tables. **Figure 4** shows all 16 of these possible truth tables for two-input gate logic circuits. In practice, only a few of these 16 are used to any degree. The most common gate circuits found in surplus are those known as *nand* and *nor* gates. **Figure 5** shows the truth table of both the *nand* and the *nor*. The three-way switch circuit of **Figs. 1** through **3** is known in logic as an *exclusive or* circuit; you're not likely to find one of these in surplus, because when a logic designer needs an *exclusive or* gate he usually builds it up from several *nand* or *nor* circuits.

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T-37-2	.37	.21	.12	.40
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T-12-2	.125	.06	.05	.25
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T-80-6	.80	.50	.25	.80
T-68-6	.68	.37	.19	.65
T-50-6	.50	.30	.19	.50
T-25-6	.25	.12	.09	.35
T-12-6	.125	.06	.05	.25
Black "W" Cores-30 MHz to 200 MHz- = 7				
T-50-10	.50	.30	.19	.60
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T-25-10	.25	.12	.09	.40
T-12-10	.125	.06	.05	.25

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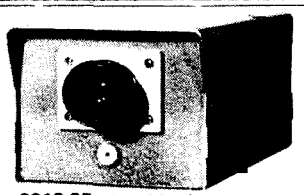
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S1	S2	OUT
Ø	Ø	1
Ø	1	Ø
1	Ø	Ø
1	1	1

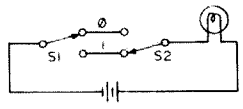


Fig. 3. Redrawn schematic and revised truth table show operation of three-way switches entirely in terms of digital logic and binary signals. Substitution of **1** *and* **Ø** *for* **on** *and* **off** *or* **up** *and* **down** *standardizes the description of circuit action.*

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	Ø
1	Ø	Ø
1	1	Ø

ALL Ø

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	Ø
1	Ø	Ø
1	1	1

AND

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	1
1	Ø	1
1	1	1

3

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	Ø
1	Ø	1
1	1	1

DRIVER 1

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	1
1	Ø	Ø
1	1	Ø

5

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	1
1	Ø	Ø
1	1	Ø

DRIVER 2

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	1
1	Ø	1
1	1	Ø

X OR

IN1	IN2	OUT
Ø	Ø	Ø
Ø	1	1
1	Ø	1
1	1	1

OR

IN1	IN2	OUT
Ø	Ø	1
Ø	1	Ø
1	Ø	Ø
1	1	Ø

NOR

IN1	IN2	OUT
Ø	Ø	1
Ø	1	Ø
1	Ø	Ø
1	1	Ø

NOT X OR

IN1	IN2	OUT
Ø	Ø	1
Ø	1	1
1	Ø	1
1	1	Ø

INVERT 2

IN1	IN2	OUT
Ø	Ø	1
Ø	1	1
1	Ø	1
1	1	Ø

12

IN1	IN2	OUT
Ø	Ø	1
Ø	1	1
1	Ø	1
1	1	Ø

INVERT 1

IN1	IN2	OUT
Ø	Ø	1
Ø	1	1
1	Ø	1
1	1	Ø

14

IN1	IN2	OUT
Ø	Ø	1
Ø	1	1
1	Ø	1
1	1	Ø

NAND

IN1	IN2	OUT
Ø	Ø	1
Ø	1	Ø
1	Ø	Ø
1	1	Ø

ALL Ø

Fig. 4. All 16 possible truth tables for 2–input gates are shown here. Tables 3, 5, 12, and **14** *have no names, while* **ALL Ø** *and* **ALL 1** *have no practical uses. The rest are all used in logic circuitry, but only some of them are available as actual gates; those which are not available as gates must be synthesized by combining actual gates to produce the desired truth table.*

IN1	IN2	OUT
Ø	Ø	1
Ø	1	1
1	Ø	1
1	1	Ø

NAND

IN1	IN2	OUT
Ø	Ø	1
Ø	1	Ø
1	Ø	Ø
1	1	Ø

NOR

Fig. 5. Truth tables for nand *(left) and* nor *gates show striking similarities. These two types of gates are the kinds most often found in surplus digital ICs. If all* **Ø** *entries in truth table for the* nand *are replaced by* **1** *and all 1's by* **Ø**, *the result will be the truth table for the* nor. *Because of this similarity, sometimes an identical pair of circuits carries different names—and sometimes the same circuit is used to perform both* nand *and* nor *functions, by reversing polarity of all signals at both the input and output for one use, and leaving polarity unchanged for the other.*

S1	S2	OUT
Ø	Ø	Ø
Ø	1	Ø
1	Ø	Ø
1	1	1

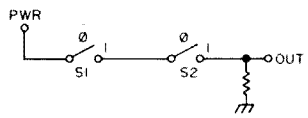


Fig. 6. Schematic and truth table for toggle-switch version of **and** *gate. Both switches must be in* **1** *position for power to appear at output terminal and produce output of* **1**; *either switch being at* **Ø** *holds output at* **Ø** *also.*

S1	S2	OUT
Ø	Ø	Ø
Ø	1	1
1	Ø	1
1	1	1

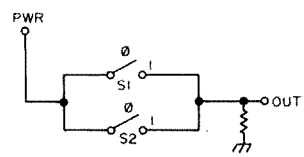


Fig. 7. Schematic and truth table for switch version of **or** *gate. Since switches are in parallel, either switch being in* **1** *position produces a* **1** *output, and a* **Ø** *output occurs only when both switches are open.*

(that is, in the dim dark ages of some three to five years ago), the most common logic circuits were the *and* and the *or* arrangements. **Figure 6** shows an arrangement of switches which produces the *and* function, together with its truth table, while **Fig. 7** shows switches to create an *or* gate.

The names are almost obvious from the circuits. In the *and*, both (or all, if there are more than two) inputs must be at the **1** logic level in order to produce a **1** output. If any input is at **Ø** level, the output is **Ø**. In the *or*, either input **1** or input 2, or input 3, or . . . being at the **1** level is enough to produce a **1** output, and a **Ø** output results only if all the inputs are at **Ø**.

Figure 8 shows both the *and* and the *or* circuits redrawn to substitute transistors for the switches. Notice that the transistor is virtually an exact substitute for the switch—but a transistor can switch from on to off in a microsecond or less, while actual switches take considerably longer.

Let's move back to actual switches one more time, though, to examine the *nor* circuit. This name is a contraction of *not or*, because, as you can see by comparing truth tables, the only difference between an *or*

and a *nor* is that the output of a *nor* is **1** under the input conditions which would make an *or's* output **0**, and vice versa.

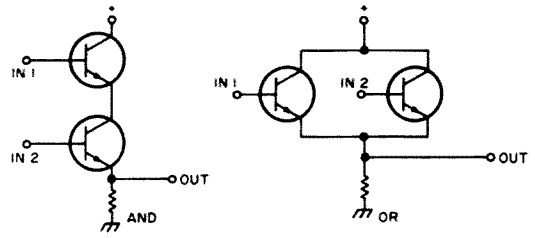


Fig. 8. Substituting transistors for the switches in Figs. 6 and 7 produces these circuits, which are workable transistor-logic versions of the **and** *and* **or** *gates. These exact circuits are seldom used in practice because the input logic levels must swing over a greater range than the output levels. Before IC usage became common, most logic circuits used diode gating; with the advent of ICs, the* **nor** *and* **nand** *circuits became the preferred versions.*

The circuit of **Fig. 9**, which is simple enough, produces a *nor* gate. If either switch is closed (the **1** position), the output signal is shorted to ground to become **0** level. If both switches are open (the **0** positions), the output rises to the level of the supply voltage and becomes a logic level of **1**.

Just by switching the names of the logic levels and switch positions, so that closed switches mean logic level **0** and ground voltage is an output level **1**, we can change this same circuit to a *nand*. If you disbelieve this apparent contradiction, check it out against the truth table. Sketch the circuit four times, setting the switches to each of their four possible combinations, and check the output voltage by name. It will follow the *nand* truth table when closed switches indicate **0** and ground output indicates **1**,

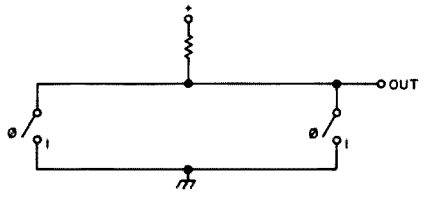


Fig. 9. Two switches and a resistor suffice to form a **nor** *circuit, which as you can see by comparison with Fig. 7 is simply an "upside down* **or**." *Turning the circuit upside down inverts the output, making it "***not or**," *which was contracted by busy engineers to* **nor**. *With switches this circuit offers no advantages over the plain* **or**, *but when transistors are substituted, a major advantage appears (Fig. 10).*

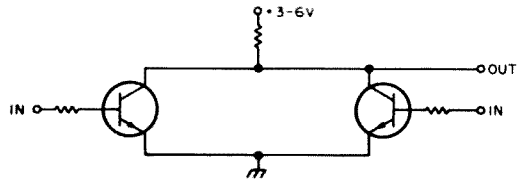


Fig. 10. Schematic of transistorized nor *gate obtained by replacing switches of Fig. 9 with type 2N706 transistors, and adding series resistors to limit base current. This is the circuit used for each gate element in Fairchild Micrologic type 914 ICs, and any RTL* nor *gate will have similar schematic. Each input requires its own transistor, with all collectors connected together. When any transistor is on, output is at ground level; output is at supply level only when all transistors are off.*

and will follow the *nor* truth table if the closed switches indicate **1** and ground output is **0**.

In actual digital logic circuits, the usual difference is that one circuit uses NPN transistors and positive supply voltages, while the other uses PNPs and negative supplies. Sometimes, designers actually do use the trick of changing logic levels in mid-circuit, so that physically identical circuits may be *nand*s here and *nor*s there, with no way to tell the difference.

But we're a bit ahead of ourselves, because we haven't converted the switch-operated circuit of **Fig. 9** into its transistor equivalent yet. **Figure 10** does so —and takes us one step further.

In **Fig. 10**, a positive or **1** voltage applied to either base resistor will turn that transistor on, which is the same as closing the switch. The output will drop to **0**. You can build the circuit of **Fig. 10** using 2N706 transistors, or you can buy it in surplus as a Fairchild Micrologic type 914 integrated circuit. If you buy a 914, you'll actually get a pair of these circuits, completely independent of each other except for the power and ground connections. The 915 is the same except that it has three transistors per logic element instead of two, which makes it a dual 3-input gate (the 914 is a dual 2-input).

Some similar circuits known as quad 2-input gates simply have four independent 2-input circuits similar to **Fig. 10** inside.

You may run into circuits called "quad 3-input gate extenders" or words similar to this. The key word in this is *extender*. Beware of them for most purposes, because

they do not include the load resistor or power supply connection. Their purpose is to be connected across the output of some other gate to provide additional inputs. The gate extender does come in handy at times, though, should you want to use some value of collector resistor other than the 640Ω which is typical of a 914 or 903.

Flip-flops

In the sometimes illogical world of logic circuits, a flip-flop isn't always. You may meet R-S flip-flops, J-K flip-flops, type D flip-flops, and delay flip-flops. You might even meet a British import here and there which isn't a flip-flop at all but bears the name of one.

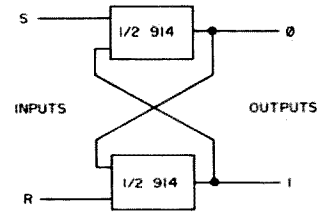


Fig. 11. By cross-coupling two halves of a type 914 IC, a type R–S flip-flop can be constructed. Two inputs for each gate are at left side of box representing gate element, and output is at right. Application of **1** *level to either the* **S** *or* **R** *input makes corresponding gate output a* **Ø**, *and if other input is also* **Ø**, *then the opposite gate's output must be* **1**. *This* **1** *feeds back to original gate to maintain a* **1** *input, and holds output conditions constant until flip-flop is switched to opposite state by applying a* **1** *to the other input terminal.*

The circuit most people think of when they hear the name flip-flop (if they think of a circuit at all) is the counting flip-flop which flips to one of its two states when a pulse arrives, and flops back to the opposite state when another pulse comes in. This one is more accurately called a trigger, or type T flip-flop –but you won't find it in surplus.

In computers, another kind of flip-flop, known as the R–S flip-flop, is often found. This one has two input terminals, and two output terminals. A 1 applied to the **S** input causes a 1 to appear at the output terminal labeled 1, and a **Ø** level to appear at the **Ø** output terminal. Both output signals remain even if the input 1 is removed.

Applying a 1 input to the R input terminal reverses the state of the flip-flop. The level at the 1 output becomes **Ø**, and the level at the **Ø** output becomes 1.

The R and the S at the inputs stand for *reset* and *set*. Some designers use **S** and **C** instead of **S** and R, to mean *set* and *clear* and thus avoid confusion between the act of resetting or clearing, and the act of re-setting or setting again.

An R–S flip-flop cannot count as does the type T; it merely remembers what the most recent signals applied to its inputs were. You won't find many R–S flip-flops in surplus either, but if you want one you can build it easily by connecting the two halves of a type 914 dual *nor* gate as shown in **Fig. 11**. A 1 applied to terminal **S** causes the output of that half of the 914 to drop to **Ø**, and this makes both the inputs to the other half **Ø**. With both inputs at **Ø**, this other half produces a 1 output at the 1 terminal. The 1 output is cross-coupled back to the other input of the first half, to hold conditions in case the 1 at terminal **S** is removed. The *reset* or *clear* condition works the same way, but the roles of the two halves are reversed.

The reason that you won't find either type T or R–S flip-flops in surplus is because a single integrated circuit was developed which can serve either purpose, as well as several additional ones. It is known as the J–K flip-flop. The name comes from IBM names for some of the signal wiring in its computers.

Like the R–S flip-flop, the J–K has two input terminals and two output terminals. However, in addition to these two pairs of terminals, the J–K always has a fifth terminal known as the *trigger* terminal, and often has either one or two additional terminals known as *unconditional set* and *unconditional clear*. The block diagram symbol for a complete J–K flip-flop, as set forth by military standards, appears as **Fig. 12**, and in this article we'll use the labels shown in **Fig. 12**. These labels are not actually as standardized as all that, though, and you may find authors using other words to refer to the same terminals.

In particular, any IBM literature you may happen to come across will refer to the **S** terminal as the J terminal, the T terminal as the **Q** terminal, and the **C** input as the K terminal. IBM uses the symbol **Q** for clock-

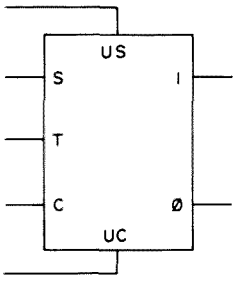


Fig. 12. Military standard symbol for J–K flip-flop, as set forth in MIL-STD-806B. Meanings of letters are explained in text.

pulse signals, while **J** and **K** are names for logic level lines to the giant of the industry.

But the military has standardized on other names: **S** for *set*, **T** for *trigger*, **C** is for *clear*, **US** for *unconditional set*, **UC** for *unconditional clear*, and **1** and **Ø** are the outputs.

The J–K flip-flop is a bit difficult to describe by a truth table, since what happens at its outputs depends on the levels present at the **S** and **C** inputs *at the instant* of a pulse transition at the T input. We'll describe action of the Fairchild Micrologic 923 series, which is typical of J–K flip-flop action.

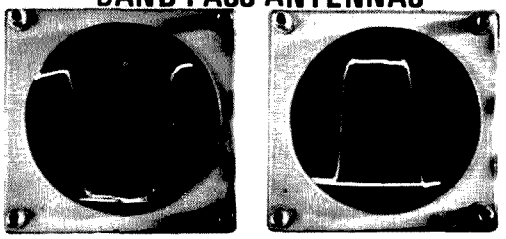
The 923 has six terminals; **S, C, 1, Ø, T,** and **US**. The **UC** terminal is omitted. If a positive logic level is applied to the **US** terminal, the **1** output terminal will go to ground level and the **Ø** output terminal will rise to nearly the dc supply voltage (which should not exceed 5V). This action occurs regardless of the conditions at the **S, C,** and **T** terminals, and is why the **U** in **US** stands for *un*conditional. This terminal is used for setting the flip-flop to a known condition when equipment is turned on, or whenever you want to clear it.

For the **S, C,** and **T** terminals to have any effect, the **US** terminal must be at ground level, ØV.

Under this condition, the levels at the output terminals will depend upon the levels present at the **S** and **C** terminals at the instant the voltage at **T** drops from positive to ground, and also (in some cases) upon the previous condition of the flip-flop.

If both the **S** and the **C** terminals are at high voltage, the negative-going transition at **T** will have no effect; the state of the flip-flop will remain unchanged.

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If S is at high voltage while C is at ground when the voltage at T drops from high to low, then the Ø output terminal will go to ground and the 1 output will climb to the positive level. That is, the 1 output will mirror the level at the S input, and the Ø output will follow the C input.

If S is at ground and C is high at the transition, the reverse occurs; Ø goes high while 1 goes to ground.

If *both* S and C are at ground when the transition occurs, the flip-flop will reverse its state. If 1 was high before the transition, it will be low afterward and Ø will be high. If 1 was low before, it will be high afterward while Ø will be low. This is the counting action of the type T flip-flop; all that's necessary, then, to turn a J–K into a counting or type T unit, is to strap both the S and the C inputs to ground.

We aren't showing you a schematic of this unit, because it's almost unbelievable. The type 923 comes in a TO-5 can or epoxy blob, the same size as most entertainment transistors; the circuit contains 15 transistors and a rather large number of resistors as well. In addition, the way in which the transistors are used to obtain desired circuit action leads directly to mass confusion upon quick study of the schematic. Some of the connections appear impossible; the designers made use of, among other things, differences in switching speed between two almost identical transistors side by side on the microscopic chip, to obtain the action of a capacitor!

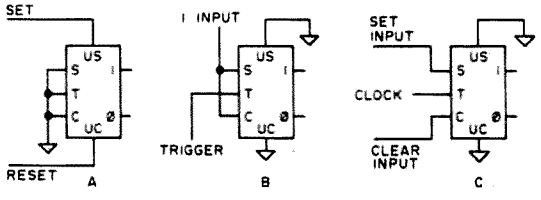


Fig. 13. Hookups for using J–K flip-flop as (A) type R–S flip-flop, (B) type T (trigger, or counting) flip-flop, and (C) delay flip-flop. Hookup A acts just like circuit shown in Fig. 11; outputs retain conditions set in by signals on set or reset lines. Circuit B reverses output conditions with each pulse applied to trigger input. Circuit C is slightly more complex. Conditions at set and clear inputs when clock pulse occurs are reproduced at outputs, until next clock pulse occurs.

Figure 13 shows the connections for using a J–K flip-flop as (a) an R–S flip-flop, (b) a trigger or counting unit, and (c) a delay flip-flop. The delay unit repeats at its output the conditions which existed at its inputs one trigger pulse time ago; it sometimes has a use in construction of electronic keys, and is the basis of such computer subassemblies as ring counters and shift registers. the situation is similar to that at the cutoff

What Have You Got?

Assuming that by now you've become sold on the whole idea and sent off for a package of ICs, you probably are in somewhat of a quandary attempting to find out just what you have on hand. Many of the surplus IC units have no identification markings which make any sense.

This comes about because most of the units available (other than those purchased directly from factory distributors) come from industrial surplus, and any identification marks on them are probably the part numbers assigned by the manufacturer who intended to use them, rather than being the type numbers put on by the semiconductor plant which made them in the first place.

Most ICs come in one of two distinct package styles. One is the multilead TO-5 can or epoxy configuration; the Fairchild 914 and 923 are good examples of these. The other is the DIP (for *dual in-line package*) which may have a varying number of connections. This is a small *flatpack* with the connections coming out on the two long sides. Many of them have 14 connections (including power and ground), with 7 coming out on each side.

If you're extremely lucky, the surplus house you bought your units from will have furnished you with a base diagram so you know which pin is which. Otherwise, there's some tedious detective work in store. It's not impossible, though.

It helps, in case you're having to figure it all out with no help from the dealer, to know whether the unit in hand is a flip-flop, a buffer, or a gate. It's also nice to know how many independent units are in the same package, because then you can get some idea of how many pins to test. But you can do without these aids.

The first thing necessary is to connect

power to the unit. Low voltage, with a current-limiting resistor of at least 1000Ω per volt of supply voltage is safest. A couple of D cells are ideal, with a 2.2 kΩ series resistor. This will give you 3V at just under 1 mA – enough to check out most circuits and not enough to harm very many. If you know which pins are power and ground, just connect them. If not, pick any pin at random as the ground and try each of the others, in turn, as the hot side. If you can't get any readings in subsequent tests which make sense, move to another pin with the hot side of the power source; after going all the way around, move to another pin and try again.

Sometimes it's handy to have a milliammeter in series with the power source. If you get nearly a 1 mA of current flowing, the circuit must be full on in the IC, and you probably have your power source connected to a pair of input terminals, or to an output terminal with reversed polarity.

With a 14-pin DIP unit, you might have to run through the whole series of identification tests 196 times to come out with an identification –but the odds favor getting one sooner. From this, you can see just how much it does help to know where the power goes in the first place.

With power connected, measure the voltage from each of the other leads to ground. Some of the leads will undoubtedly measure nearly full supply voltage, and others will measure at ground. Leave the meter on one of those showing high, and short each of those showing ground, in turn, to the supply (at the IC side of the current-limiting resistor; it won't hurt to use another 2.2 kΩ resistor in series, if you're the cautious type). If any of these causes output voltage to drop to ground, make a note of the pins involved.

After all the no-voltage pins have been tried, try shorting the other high-voltage pins to ground, one at a time. If one of them brings the meter to zero, make a note of it.

When all of the pins which originally showed voltage have been checked out, move the meter to one of the pins which showed zero volts originally, and try the same thing again with all the other pins, noting any which cause voltage to appear, and what was done to each. Go all the way around with this series of tests, too.

By now, your notes will present a complete truth table for the unknown unit. The next step is to study it carefully to see if it falls into any of the patterns of Fig. 4. Any combinations of pins which produce such a pattern probably form an independent gate element within the IC; they should be checked out carefully by connecting the meter to the apparent output pin, and

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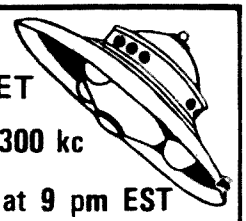
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applying the appropriate high or low levels to all the input pins at the same time.

A Few Helpful Hints. Most of the gate functions cannot be detected by single-input-pin tests such as those described here. If you find apparent "inverter" action from several input pins to the same output pin, the apparent output pin is probably the actual output pin of a gate element of some sort, and the apparent input pins are probably the actual gate element input pins. Try combinations of high and low levels at all the input pins simultaneously while reading level at the output pin, to find any similarities to the truth tables of **Figs. 4** and **5**.

If any of the single-input-pin tests cause an output voltage level to switch and stay in the opposite condition, you probably have a flip-flop; gates do not stay in alternate states, but hold their output levels only so long as inputs are supplied, while flip-flops "remember" inputs and do not need to keep them applied to have a changed output. If you find a suspected flip-flop, try multiple-pin tests by connecting all pins except the one you're testing and the output pin you're measuring from, to ground. When you find the single pin which causes output to reverse when the contact is either made or broken, under these conditions, you know the T input terminal and one of the two output terminals. From there, it's trial and error to find the rest of the connections.

After a little experience with this type of detective work, you'll probably develop a feel for it which may defy explanation. If you want to develop the feel without all the trial-and-error headaches, invest in a few units which come with connection diagrams (if you can find such), and practice with them.

Using Logic Elements Illogically.

While it's possible that you may become so fascinated with the possibilities inherent in logic circuitry, as such, and forget all about radio, that's not very likely. It's much more probable that you're only messing with all this Boole (to steal a good pun) because you want to make use of the ICs in some circuit that has nothing to do with electrical logic machines.

In that case, you'll probably welcome this portion of our discourse, because the rest of this article is devoted to some typical ways of using digital IC elements in ham radio.

The most versatile of the ICs for such uses is probably the 2-input *nor* or *nand* gate, of which the 914 is typical. A glance back at the schematic of this gate, **Fig. 10**, will show the resemblance between the *nor* gate and a *long-tailed-pair* differential amplifier circuit. All that you have to do to turn a 2-input *nor* or *nand* into a long-tailed-pair is to add the "tail," a resistor, between the IC's ground terminal and the actual circuit ground. The resistor value is not particularly critical; anything from 47Ω to 1 kΩ might do it, depending upon the signal levels involved and so forth.

You may also find it necessary to provide some forward bias to each of the two bases, by connecting a voltage divider to each of the input terminals. The complete circuit is shown in **Fig. 14**, but parts values must be determined by experimenting for each application. This circuit has been used as a mike preamp, and might also have other uses. High-frequency response is not particularly good, because the series resistors inside the IC (see **Fig. 10**) act with the junction capacitance to form a lowpass filter.

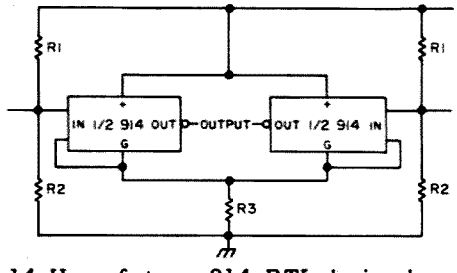


Fig. 14. Use of type 914 RTL logic element as differential amplifier is shown here. Values for R1, R2, and R3 must be determined by trial and error, but one such application has successfully used 1.8 kΩ at R1, 1.3 kΩ at R2, and 330Ω at R3. These values may be used as starting points. Output is taken directly from output pins of IC.

We already saw, in **Fig. 11**, how to cross-connect one of these gates into an R–S flip-flop, otherwise known as a *bistable multivibrator*. If we simply duplicate that hook-up, but put one capacitor and appropriate resistors in place of one of the direct wires, as in **Fig. 15**, we have a *one-shot* or *monostable multivibrator* which performs nicely as the frequency divider in a frequency standard. The frequency adjustment depends

upon both the capacitor size and the resistor values. Vary the capacitor until you're in the right ball park, and then use the resistance as a "trim" adjustment.

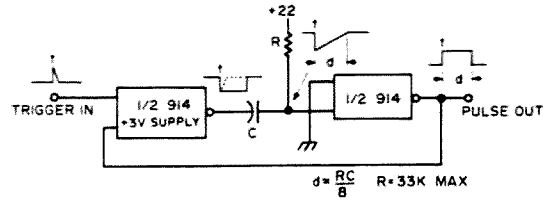


Fig. 15. One-shot circuit is easily built from 914 IC by adding single capacitor and external resistor. If 3V supply is used for IC, and 22V supply to drive external timing resistor, duration of output pulse will be almost exactly 1/8 the RC time constant, with R in ohms and C in farads. Maximum resistance usable for R is 33 kΩ to permit turn-on current to flow. Capacitance C, however, may be any value desired to achieve required output pulsewidth.

By substituting a crystal for the other cross connection, as **Fig. 16** shows, we can turn the dual *nor* gate into a crystal controlled oscillator with a high-harmonic waveform. It makes a fine frequency standard, especially if one or two dividers similar to the **Fig. 15** circuit are added.

If you want a free-running oscillator, you can get it by using capacitors on both sides. The circuit is just like **Fig. 16** except that another capacitor replaces the crystal. Frequency will depend upon values of both capacitors, and both sets of resistors.

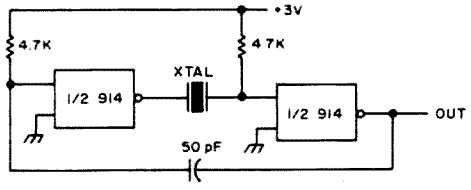


Fig. 16. Minor modifications to one-shot circuit, including substitution of a crystal for the timing capacitor and insertion of a capacitor in the dc feedback loop, turn it into a crystal-controlled oscillator which may be used for a frequency standard. Output is rich in harmonics, and this circuit is not recommended for transmitter use for that reason.

The *synchronous detection* technique for reception of AM, FM, and DSB signals has long been of interest to many of us, but too many transistors or tubes have been necessary in most circuits for synchronous or phase-locked detectors. Surplus ICs may, at long last, make phase-locking practical for ham receivers. (See W2EUP's frequency synthesizer description in 73, February 1970.) **Figure 17** shows a voltage-controlled oscillator (VCO) designed several years ago by a Motorola engineer using the Motorola MECL dual *nor* gate. Frequency varies over a 10-to-1 range as control voltage is varied from 1–7V. Both capacitors are the same value, and they control center frequency. Minimum value is about 110 pF, which provides a center frequency of about 2 MHz; maximum is 100 μF, which provides a center frequency of about 3 Hz (lowest frequencies with these two values are 750 kHz and 0.5 Hz respectively). For a 455 kHz i-f strip, 470 pF values would be about right.

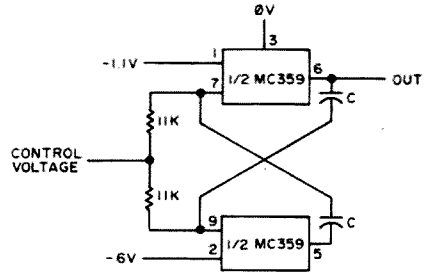


Fig. 17. Voltage-controlled oscillator can be varied over nearly 10-to-1 frequency range simply by varying control voltage. This circuit may be used as part of phase-locked detector.

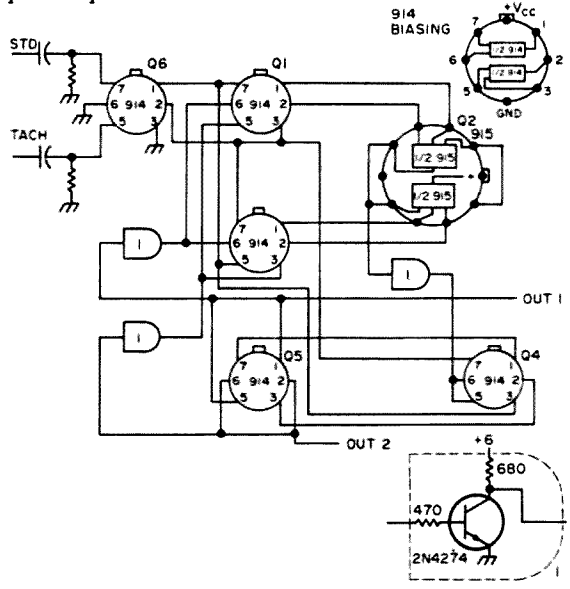


Fig. 18. This rather complex arrangement of ICs is a frequency comparator and phase detector. The unknown frequency is fed into the TACH input and the standard to which it is to be compared goes to the STD input. Output level indicates whether TACH is higher or lower in frequency than STD. OUT 1 and OUT 2 are of opposite polarity. Type 915 IC (Q2) is same as 914 but has 3-input gates rather than 2-input elements.

Figure 18 shows the frequency comparator or phase discriminator which goes with the VCO to provide half of a synchronous detector. This circuit was developed at Fairchild, and is not necessarily directly compatible with the VCO, but it should be possible to blend them together with a little trial and error.

The circuit of Fig. 18 accepts input signals at two connectors, labeled *REFERENCE* and *SIGNAL* in the drawing. It produces a single dc output. If the *SIGNAL* frequency is lower than that of the *REFERENCE*, the dc output level will be low. If the *SIGNAL* frequency is above the *REFERENCE*, the dc output level will be high. If both *SIGNAL* and *REFERENCE* are at the same frequency, the dc output level will be between the low and high levels, and will be determined by the phase relation between the input signals.

Unlike phase discriminators which make use of tuned circuits, this one has no humps in its response curve. The output will follow phase variations of the input faithfully, and can be filtered and used to drive the VCO in the classic phase-lock detector arrangement.

A somewhat less complex circuit which has nothing to do with radio but which may be of interest to the sports-car fanatics among us is in Fig. 19. This is a combination tachometer and dwellmeter, built around a single quad dual-input *nor* (Motorola MC724P). The gates at terminals 1-2-3 and 12-13-14 form a one-shot flip-flop timed by the 0.5 μF capacitor and 20 kΩ resistor. The gate at 5-6-7 is used simply as a driver, and the remaining gate (8-9-10) is the meter driver. Power is furnished by a pair of dry cells. In switch position 1, power is off. In position 2, the circuit acts as a tach, and resistor R1 should be adjusted to produce a 900 rpm reading when 60 Hz voltage is fed in. In position 3, it's a dwellmeter, and R2 should be set so that full-scale reading on the meter is obtained with the input terminals shorted. This will be 45 degrees of dwell for an eight-cylinder vehicle, 60 degrees for a six, and 90 degrees for a four. The meter can also be read as indicating percentage of time that points are closed, but most specs for tuneup give dwell readings in degrees.

This is, of course, only a sampling of the various uses which you can make of digital ICs. A little experimentation will probably result in several new ways – and now that they're in surplus, they're cheap enough to permit such experimentation. . Jim Kyle■

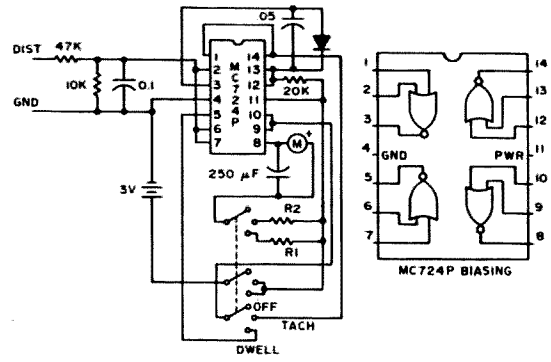


Fig. 19. Single IC chip provides tachometer and dwellmeter for auto enthusiasts. Tachometer uses one-shot formed by gates at terminals 1-2-3 and 12-13-14, with 20 kΩ timing resistors and 0.05 μF timing capacitor. Dwellmeter is driven by gate at terminals 5-6-7. Gate at terminals 8-9-10 is used only as meter driver, and capacitor across meter serves to damp individual current pulses. Power is supplied by 3V battery. Calibration is adjusted by R1 and R2.

VOX POP

Monthly Report of Activities on our Bands

Please send reports of interest on the band of your choice to Vox Pop, 73 Magazine, Peterborough, NH 03458. Use a postcard and indicate on the top the band being reported. Any news of interest will be considered grist for the mill...DX reports (including time, frequency, QSL manager), new FM repeaters, nets, emergency operations, contest high scorers, county operations, skip openings on VHF's, aurora, meteor scatter, moonbounce, anything you think will be of good general interest. The deadline for each issue is the tenth of the month. Material received April 10th will be scheduled for the June issue, which comes out in early May.

REPORT FORM

Please send all your reports to VOX POP on a postcard or QSL card, keep them as short as you can so we don't have to wear out our blue pencil. At the top of the card print clearly the band that the report is for. All reports will be listed by band, so if you are reporting on more than one band use more than one card.

(continued from page 75)

assembly and install in 12V base assembly.

NOTE:
The letters A and B are stamped on the bottom of the base assembly. Plug the crystal into the socket on the A side.

(4) Place the spacer plate between the crystal and the heater element and replace the cover. Make sure that the polarity of the cover and base agree.

(5) Insert the crystal assembly in the proper socket.

6 to 12V Conversion Power Supply

a. Vibrator Connections

(1) Disconnect the shielded lead from the two 2.9 mH choke coils located near the center of the chassis (Fig. 1).

(2) Disconnect the other ends of the two chokes from the two 0.5 μF capacitors (C4 and C5). These two choke coils are not used in the 12V circuit.

(3) Disconnect the black-yellow transformer lead from capacitor C4(0.5) and disconnect the red-yellow transformer lead from capacitor C5(0.5). Tape each lead separately and dress it out of the way.

(4) Disconnect the sleeve-covered lead from pin 3 of the vibrator socket. Use this lead to connect capacitors C4 and C5 in parallel. Do not solder the connections to C4 and C5 until completing step 15.

(5) Disconnect the black, yellow, and red leads from pins 1, 2, and 4 of the vibrator socket.

(6) Remove the lead between vibrator socket pin 6 and ground.

(7) Remove the 100Ω resistors connected between vibrator socket pins 1, 2, 4, and 5 and ground.

(8) Connect the red and black leads to the ungrounded terminal of C4 or C5 (changed to C104 and C105 on schematic).

(9) Connect pins 2 and 4 of the vibrator socket and then ground pin 4 at the ground lance near pin 5.

(10) Connect a 270Ω resistor from vibrator socket pin 1 to ground.

(11) Connect a 270Ω resistor from vibrator socket pin 5 to ground.

(12) Connect a 7.5Ω resistor from vibrator socket pin 6 to ground.

(13) Connect the yellow transformer lead to vibrator socket pin 1.

(14) Connect a 20Ω resistor from vibrator socket pin 3 to the ungrounded terminal of capacitor C4.

(15) Connect the shielded lead, which was disconnected from the 2.9 mH choke coil in step 1, to the ungrounded terminal of capacitor C5.

b. Push-to-Talk Relay Modifications

(1) Remove the white-black lead connected between terminal 8 of relay K1 and terminal 14 of transmitter terminal strip E2.

(2) Remove the white-black lead which connects between terminal 14 of terminal strip E2 and pin 4 of power plug P1.

(3) Connect a black-white lead from terminal 8 of relay K1 to terminal 4 of the power plug.

(4) At terminal board E1, disconnect the 24 AWG brown lead (running from the relay coil lug) from terminal 9. Reconnect this end of the lead to terminal 14 of terminal board E2.

c. Fuses

(1) Remove the two 15A fuses from the fuseholder.

(2) Paint out or use tape to mask over the markings on the fuseholder. It is recommended that 6.25A now be marked on the fuseholder to insure that oversize fuses are not used.

(3) Place two 6.25A fuses in the fuseholder.

d. Terminal Strip E1 Modifications

(1) Connect a 25 μF capacitor from terminal 9 to terminal 12 of receiver terminal strip. Connect the negative side of the capacitor to terminal 9.

(2) Connect a 25 μF capacitor from terminal 12 to terminal 15 of the receiver terminal strip. Connect the negative side of the capacitor to terminal 15.

That's all there is to it. The worthless old 6V surplus mobile is ready to go in your 12V auto.

. . . W6YAN ■

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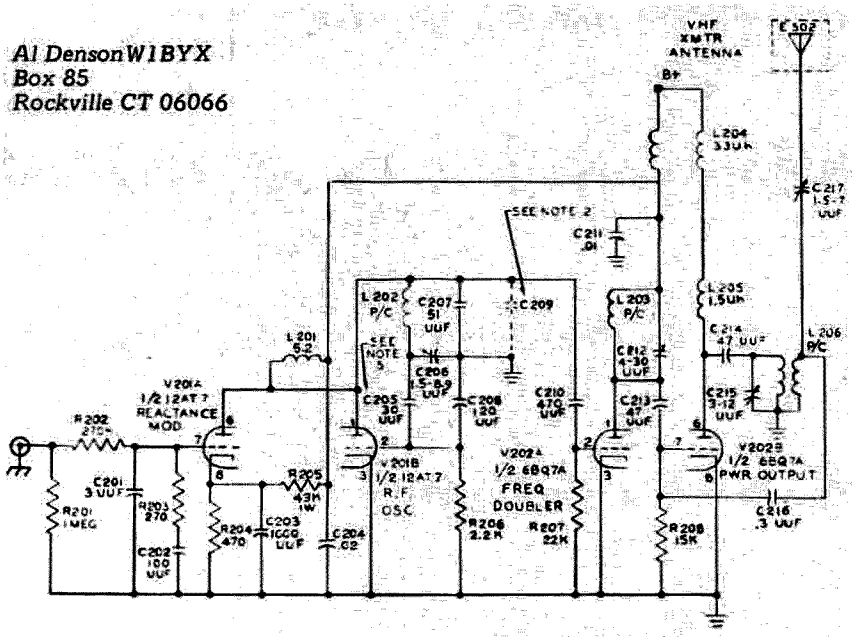
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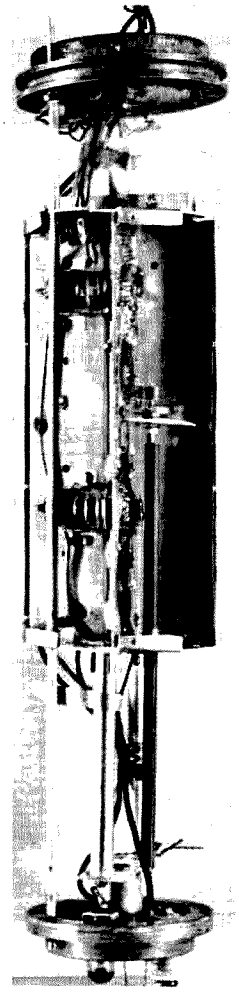
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Converting the AN SSQ-23A Sonobuoy to a 2W FM Rig

Al Denson W1BYX
Box 85
Rockville CT 06066





The AN/SSQ-23A "Sonobuoy" transmitter which has recently become available on the surplus market is one of those rare gems in today's depleted surplus market which is adaptable for amateur radio use with little work and low cost.

As originally made for the government, this unit was designed to be dropped into the sea from an aircraft as an expendable unit which detected underwater sounds by means of an underwater microphone. The original frequencies covered the range from 162.25 to 173.50 MHz.

A self-contained battery supply of 13V is tapped at 6.5V to feed a transistorized dc power converter. The normal battery drain was 2.25A total for both 6.5V sections. The dc power converter assembly is a small transistor switching unit which converted the 13V to 160V B+ for the transmitter.

The entire transmitting assembly consists of two printed circuit boards, the first of which contains a 12AT7 tube used as the rf oscillator and reactance modulator with a 6BQ7 used as a frequency doubler and power output stage. The second board contains two 12AX7s; one is used as an audio amplifier, the other as an amplifier/AGC audio network. Diode clippers were used for amplitude limiting of the audio component.

To convert the assembly to 2 meters, add one small 18 pF silver-mica capacitor in parallel with C206 as a pad to lower the output frequency. Connect a microphone to the input formerly used by the underwater "microphone" transducer and connect two 6V batteries in series to the power supply. Voila! You're on 2 meters FM, and ready to operate through the local repeater. And toned repeaters are no problem either; a tone oscillator may be very simply added by means of the built-in neon-tube relaxation oscillator circuit.

The schematic shows the 2W transmitter board only. The poor quality of the schematic is attributable to the fact that it was reproduced from a xerographic print of the original manual. . . . W1BYX ■

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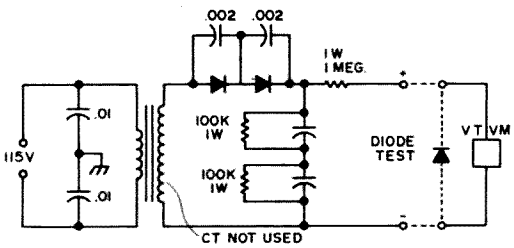
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EASY DIODE TESTING

Edwin Kirchhuber K4JK
2804 Broadview Drive
Huntsville AL 35810

With the advent of "bargain" diodes, we must test before using, especially if they are to be used in series (what else). The simplest method I have found is to use the good old vtvm and a power supply capable of providing 1000V. I used a 40 mA transformer (275-0-275V) in a half-wave circuit. The filter is a couple of 450V electrolytics in series. Any value from 8 to 80 μF is okay. The hot lead coming from the power supply has a 1 MΩ, 1W resistor in series to limit the current. The vtvm is placed across the diode test points and the readings are taken.

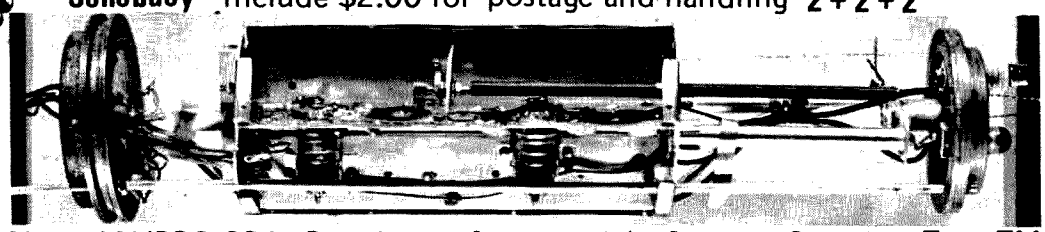
To check the characteristics of the "mystery" diode, put its cathode to the positive test point, and the anode to the negative test point. Read the voltage on the vtvm. If, for instance, it reads 300V, a safe PIV working voltage would be 2/3 of that — or 200V. To test for forward characteristics turn off the supply and reverse the diode. Set the vtvm to the 3V scale, turn on the power and read the voltage drop across the diode. It should not exceed 3V. Over that it is no good (open). No voltage indicates shorted diode.



To use diodes in series, select like units and be sure to use a capacitor across each to bypass the possible spikes that come from on-off operation of the power switch.

. . . K4JK ■

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TURNING THE AN/GRC-9 INTO A NOVICE RIG

. . . and it puts out a husky 15W on CW.

The surplus situation out here has been pretty bleak for quite a while, so I figured my luck was bound to change. While wandering through a local junkyard I noticed a small olive-drab box on the scrap pile. Inside was a compact transmitter–receiver covering 2 to 12 MHz! The junkie had decided not to melt it down because it had too little copper in it! After brief negotiations I parted with ten bucks and brought home the set. Since then I have run across others. They are apparently being phased out by the army. The sets I have seen have all required minor repairs, but the performance is well worth the effort.

The AN/GRC-9 is a small five-tube transmitter and seven-tube receiver designed for infantry packset use and for installation in vehicles. The receiver has a built-in 200 kHz crystal calibrator. The actual tuning range is from about 1.8 to 12 MHz so you can cover 160, 80, and 40 meters. The transmitter can be either crystal controlled or vfo. Full break-in is provided and there is a CW sidetone and provision for netting.

The set was designed for CW, MCW, and AM operation. The MCW mode is illegal, and the suppressor grid AM feature is practically worthless. However, CW performance is quite good. Power output is 15W, but can be increased. One of the best features is an ingenious antenna matching system that will match anything from a short whip to a dipole.

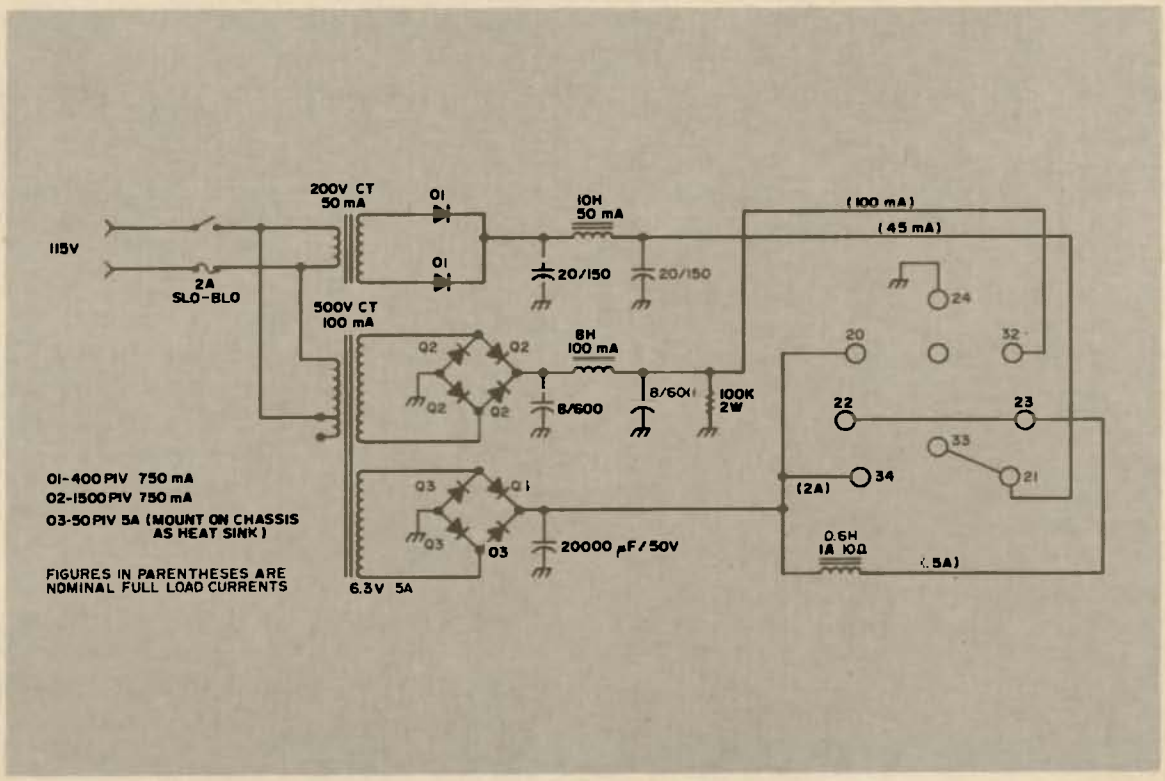
The first step in getting the set on the air is to supply power. For mobile or portable use the army used the PE-237 vibrapack, GN-58 hand generator, or DY-88 dynamotor. The PE-237 is available in quantity, but is useless. Reliability is terrible; it's bulky and the big vibrators are hard to find. The DY-88 is good and will operate from 6, 12, or 24V; but it, too, is quite bulky. The GN-58 hand-crank generator is fun for field portable use, but soon you run out of friends to turn the crank. The supply shown in Fig. 1 provides all necessary voltages and is easily run from a dc-to-ac inverter for portable operation. Incidentally, it will also operate the BC-1306, which is similar to the AN/GRC-9 but covers only 3.8 to 6.1 MHz.

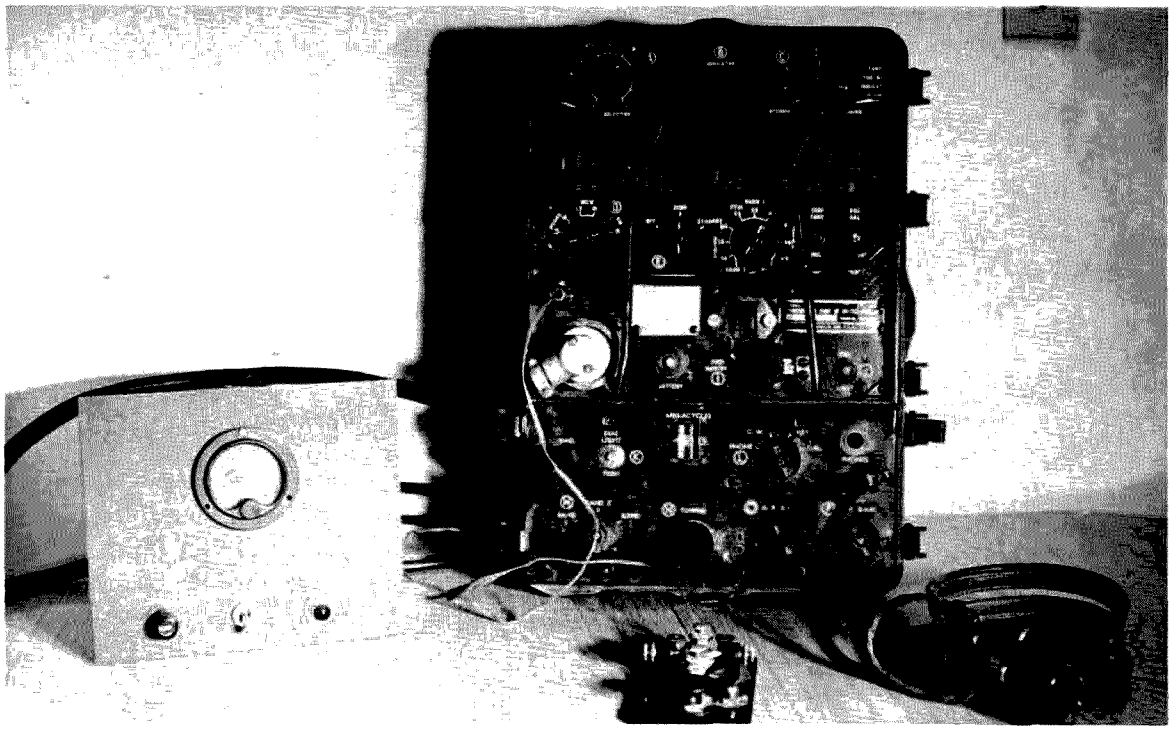
Don't try to change the connector on the transmitter. Get a CD-1086 cable or a PL-279 connector. Watch out for the CD-435 cables. They are quite common and are identical in appearance to the CD-1086. If you get one it will have to be rewired as the pin for the +500V is jumpered to the 1.4V filament pin!

After completing the supply, carefully check your wiring and connect the supply to the set. Plug in phones (be sure the impedance switch at the back of the receiver is in the correct position), key, and antenna. The phone jack is also the switch for turning on the receiver filaments. Turn the power supply on and set control E to STANDBY or SEND. Set control A for the type of antenna in use. Set control D to CW–HI. Now measure the voltages. The metering socket, X-110, provides a convenient point for measuring the 6.3V filament and plate voltages. Pin assignments are stenciled on the back plate of the transmitter. The 2E22 plate voltage should be between 425 and 600V. Receiver plate voltage should be 105V, and the 6.3V filament shouldn't be less than 6.0V. The receiver filament voltage is measured on pin A of the BATTERY connector. It should be between 1.2 and 1.4V.

The controls are well marked and self-explanatory; the "net" provision turns on the receiver bfo and the transmitter vfo for zero beating. The calibrate position activates the 200 kHz crystal oscillator which is used

Fig. 1. Power supply for AN/GRC-9 and BC-1306 transmitter/receiver.





You can save yourself a lot of grief by using the connector already provided on the AN/GRC-9. In the photo here, the homebrew power supply (left) feeds the unit through its original mating connector on the front of the unit. After minimal conversion, all you need to do is add a key and a set of headphones as shown, and you're on the air.

for calibrating the transmitter vfo using the screwdriver-adjusted OSC/CAL adjustment (control H).

The transmitter's crystal oscillator always operates into a doubler stage, so the crystals must be chosen to be at half the desired operating frequency. Standard FT-243 types can be used. Provision is made for two crystal controlled channels per band.

With the power supply of Fig. 1, the transmitter will operate break-in in either the SEND or STANDBY positions. After a suitable warmup, tune in the desired signal on the receiver. Switch control L to NET and adjust the vfo for zero beat. Now switch L to CW. Set control A to the highest number for the type of antenna in use. Close the key and adjust control C for maximum brilliance on the indicator (which is an NE-16). This will coincide with maximum plate current. If no peak is observed, change A to the next lowest setting and repeat until a peak is observed.

As with all low-power sets, special consideration must be given to the antenna system. For really portable operation, be sure to have a good ground or get the counterpoise sets (CP-12 and CP-13) that were designed for use with the set. A doublet antenna made with 72Ω twinlead is recommended. Antennas AT-101/GRC-9 and AT-102/GRC-9 are specially designed longwires having jumpers for adjusting the frequency. These are desirable accessories.

In the PHONE position, the 2E22 filament is turned on by the transmit relay so there is a delay of about 3 sec after you press the push-to-talk switch. The 2E22 is a rare bottle to come by.

You can substitute an 807 by replacing the plate cap connector, clipping the lead going to pin 4 of the socket, and connecting pin 4 directly to the chassis. But the set will operate in the CW mode only now.

Don't jack up the plate voltage for the final amplifier over 600V as the rf components won't take it.

This set is excellent for the Novice as well as the portable CW enthusiast. Detailed troubleshooting information is contained in Technical Manual TM 11-263.

. . . W6JTT ■

STAFF

Getting Your Extra Class License

Part XIV: Measurement

Most of our discussion, so far in this Extra Class study course, has revolved around the theory of things—the "why" of the subjects covered on the FCC examination.

But you're undoubtedly aware that when theory and practice agree, at least one (and usually both) is probably in error—at least, so one of Murphy's famous laws would have us believe.

Actually, a properly framed theory must agree with what actually happens. If it doesn't, then it's not properly framed. There's just one rub—before you can compare theory and "what actually happens," you have to know what's "actually" happening. And that's where the fine art of making measurements comes in.

Measurements are an essential part of all electronics, for exactly this reason. They are the link between theory and practice. What's more, in ham radio measurements provide the assurance that your operation is within legal limits, both in the amount of power you use and the part of the rf spectrum your signal occupies. Since measurements are so essential, they are included in the Extra Class examination—and this time, we're going to concentrate on several aspects of the measurement problem which we haven't examined before.

We'll be covering the following questions from the FCC study list (as always, the numbers are those in the study list):

4. What precautions should be taken when measuring the rectified grid voltage in an oscillator with a dc voltmeter?

12. An oscilloscope is used to study the relationship between the input and output of an amplifier produced by a voice signal. How would the scope pattern display a linear relationship between the input and output signals?

35. How may an amateur check his transmitter for spurious sidebands?

37. Define the term decibel. How is the decibel used for voltage and power calculations?

60. How does a cathode-ray tube operate? What magnitude of voltage is normally used to bias the plates of a cathode ray tube? What purpose does this magnitude of bias voltage serve?

65. What means may be employed to measure low frequencies? High frequencies? VHF and UHF?

Rather than attempting to provide specific answers to these specific questions, we'll follow our usual practice of rephrasing the questions into more general terms covering the same subjects.

For openers, let's find out "How can we make accurate measurements?" Then we'll turn to rf measurements in particular by asking "How can we measure rf without lab equipment?" Having eliminated lab equipment, we will next turn our attention to an instrument which was considered only as lab

gear up until a few years ago as we find out "Why use an oscilloscope?" and finally we'll tackle a bit of unavoidable (but, we hope, not painful) mathematics by asking "What are dB?" All set? Let's get with it.

How Can We Make Accurate Measurements? In order to make accurate measurements, it helps to have a clear idea of just what "measurement" amounts to. We went through this in extensive detail in our earlier Advanced Class study course (now available as a book; order it!) and we won't go through it again, except to point out that any measurement is actually a comparison between an unknown quantity and a standard.

As it happens, only three basic causes of inaccuracy in any kind of measurement exist. If you can get rid of all three, you can't help but make accurate measurements. Unfortunately, we can never escape one of them, and so no measurement can ever be completely accurate. The best we can hope for is an *acceptable* degree of accuracy in our measurements. Just how accurate we must be to be acceptable is determined entirely by the purpose for which the measurement is being made. That is, if we only want to know whether our transmitters are generating output in the 80 meter band or on 40 meters, an accuracy of several dozen kilohertz is acceptable. But if we're hugging the band limit just as close as we dare in hopes of getting a better shot at some DX prize, then we need accuracy measured in hertz or even tenths of hertz.

The three basic causes of inaccuracy in measurement are: 1) improperly calibrated standards and/or instruments; 2) using the wrong instrument for the job; and 3) using the right instrument in the wrong way.

The inescapable inaccuracy in any measurement stems from the fact that perfect calibration is impossible. Even our "standards" have some small degree of built-in error. For most practical purposes this doesn't matter too much, but every now and then it fouls things up rather smartly. One example is in the measurement of frequency. Most of us take it for granted that WWV is an absolutely accurate standard of frequency. In point of fact, it is not. The accuracy of WWV is only about one part in 10,000,000,000,000. For almost any ham purpose, this is adequate, and our assumption is safe. When measuring time intervals of a microsecond or so, however, cumulative error can creep in from this source.

The more important side of our WWV example is that the signal has that accuracy only at the WWV transmitters! As soon as it leaves the transmitting antenna and is propagated several hundred to several thousand miles, often by way of one or more ionospheric jumps, the varying distance over which it travels introduces additional inaccuracies—and these cannot be compensated for by any techniques now known.

The problem was sufficiently serious, in this day of fractional-microsecond accuracies required for space probes, that a special low-frequency service was established to provide ground-wave propagation of the WWV signal on a global basis. This takes much of the propagation error out of the standard—but not all, and the standard isn't precise to begin with.

On a more practical level for us, any instrument which we use for measurements must be calibrated to some kind of standards, and the accuracy of the measurements made cannot be better than that of the instrument's calibration. Fortunately, for most ham purposes an accuracy of 2 to 5% is more than adequate. The only major exceptions are the measurement of frequency and of time, and for both of these far more accurate standards are readily available.

Mention of using the "wrong instrument" for any measurement may bring to mind immediately visions of an elaborate lab filled with exotic test equipment. However, for our purposes most of it is totally unnecessary. The ham who knows what he's doing and how to use the equipment he has can make almost any measurement he's ever likely to need with nothing more elaborate than a good vom, his regular station transmitter and receiver, and a moderately stocked junkbox from which to build any special adapters for special jobs.

It's a little easier if the list of test equipment includes a vtvm capable of reading both ac and dc voltages as well as

resistance; in this case the quality of the vom can be considerably less since its primary purpose then will be the measurement of dc. A scope helps too, but that's another question on our list so we'll ignore it for now.

Even with this restricted list of test equipment, it's not too difficult to use the wrong instrument for the job. A classic example, which has probably happened at least once to anyone who has ever used a voltmeter on both ac and dc voltages, is that of leaving the meter set for ac while measuring dc. The needle will still indicate, but the calibration is way off because the rectifiers necessary to measure the ac voltage offer some resistance to dc, and the scale calibration usually includes an automatic conversion from peak-to-peak or average readings (which is what the meter actually measures in almost every case) into rms readings, which are the values we usually use to refer to sine-wave ac voltage or current.

It's also spectacularly easy to leave the meter set on a resistance scale and attempt to measure high voltage; in this case, you usually have no doubt about the fact that something went wrong. Rather than attempt to straighten the bent needle, it's usually best to purchase a new meter!

But a little forethought and caution (and, let's face it, some bitter experience too) will help you avoid this cause of inaccuracy. By far the largest source of inaccuracy in most electrical and electronics measurements comes from using the right instrument, but using it in the wrong way.

The list of examples of using the right instrument in the wrong way is almost endless; we can show only a few. One of the more obvious is to attempt to measure a high value of resistance (say, a couple of megohms or more), using a vtvm on the highest scale. So far, so good. But just to make sure that the test probes are in good contact with the resistance being measured, let's grasp one in each hand and press it firmly against the terminal or lead it's supposed to touch.

Surprise! No matter what the actual resistance, the meter reading will usually be around half a megohm. For some people, especially on a hot and humid day, it will be much much less. After all, the human body has resistance too, and it varies from as little as 10,000 ohms up to two or three megohms (for dry skin). Putting this resistance in parallel with the resistance being measured plays hob with the measurement.

A more subtle error in the use of measuring instruments occurs whenever we forget that any meter requires *some* power out of the circuit being measured. In other words, the meter will load the circuit. This becomes most apparent when you attempt to measure the voltage between a hot chassis and ground, especially if the chassis is hot because of a very-high-resistance leakage path through supposedly good insulation. The "circuit" we're measuring in such a case is the series circuit from power line through several hundred thousand ohms of leakage resistance to the chassis itself, through ground, back to the grounded side of the power line. If a 25-megohm (input resistance) vtvm is used to measure voltage between the chassis and ground, you'll probably read about the same voltage as you would get from simply measuring the power-line voltage itself.

But a 20,000 ohm-per-volt (Ω/V) vom is adequate to make this measurement, if it's used properly.

Setting it to the 150-volt or even 300-volt ac scale, however, is not proper use. On those scales, the average hot chassis will measure out at only 30 to 50 volts—from ¼ to ½ the actual voltage present. Because on the 300-volt scale, the meter's total resistance is only about 1.5 megohms (a 20 kΩ/V meter typically has only 5 kΩ/V sensitivity on its ac ranges) and this, in series with approximately equal quantities of leakage resistance, cuts the voltage *at the meter* way, way down.

The proper technique, in this case, is to set the vom to its highest ac voltage scale and then make an educated guess about the reading. After all, if you measure anything over 80 to 100 volts you know something's wrong; absolute precision isn't necessary in this case. And on the highest scale, the meter's resistance is highest so that circuit loading is least.

The same principle applies to measuring avc voltages in receiver circuits, and fre-

quently to the measurement of screen-grid voltages (if they are obtained via series dropping resistors). The series resistance of a typical avc circuit is in the megohms; even a vtvm loads such a circuit slightly, and an ordinary vom will impose such a load that the measurement will not only be inaccurate but the circuit will fail to work properly so long as the meter is connected.

This whole business of "loading," incidentally, is the reason that the vtvm was invented in the first place. By using a dc amplifier between the test probe and the meter, less power need be taken from the circuit and so less load is imposed by the measurement.

When attempting to measure dc voltages in the presence of rf voltage, things get even trickier. Then an rf choke needs to be connected between the test probe and the measurement point, as close to the measurement point as possible, to keep the rf out of the meter and let only the dc through. At the same time, the possibility of loading the circuit down by too low an input resistance of the meter is present. A typical vom on the 50-volt scale offers only one megohm input resistance; many oscillators, for example, use 470,000-ohm grid-leak resistors. Shunting this with a 1-megohm load will cut the actual resistance in the circuit down to about 300,000 ohms, which amounts to a 33% reduction of the intended resistance. This may cause circuit malfunction.

If the need is to measure rf in the simultaneous presence of dc, the problem is even trickier. RF voltage measurements are usually made by use of an "rf probe" which is simply a crystal diode detector mounted at the end of a test probe. These usually include a blocking capacitor to keep dc out of the diode, but are also usually limited to voltages smaller than about 20 volts peak. If the rf voltage to be measured is greater than that, then a capacitive voltage divider needs to be rigged up to reduce the voltage applied to the probe into the 20-volt range. This, however, increases circuit capacitance—and would undoubtedly detune any oscillator.

The vom and vtvm, between them, will take care of just about any measurement of voltage, current, or resistance you normally need to make, except for the measurement of very small rf voltages (such as those present on the antenna lead-in from received signal). For these, we can use the station receiver—but not in the customary manner of just reading the S-meter. We'll look at this in a little more detail in our next question—for right now, the hint is this: remember that measurement is simply a process of comparison, and almost any indicating instrument has high accuracy when it's used to compare two quantities (in contrast with its undetermined accuracy as a measuring device all by itself).

To measure time, the station receiver comes into play again. Tuned to WWV, it provides a precise source of 1-second timing "ticks." For measuring much longer times, a clock or watch is a little handier—but the measurement of time is not, in the usual course of events, a normal electrical measurement.

To measure power, some professionals use a special wattmeter. We can achieve the same result by measuring voltage and current at the same time, and plugging them into the power formula. If the power we're measuring is rf, we simply use rf instruments. But these aren't on our list, so to manage with the instruments we have, we can rig up an rf probe to permit measurement of rf voltage and then measure the voltage present across a known resistance. Then we square the voltage and divide the product by the resistance, to get the power in watts.

To sum up, we can use the vom and vtvm, when we take the proper precautions to avoid loading down the circuit under test and to assure that only the desired power gets into the meter, to find out almost anything we want to know about dc, or about any qualities of ac which can be converted meaningfully into dc levels to drive the meters.

But we cannot use these instruments, directly, to make measurements of those qualities of ac which do not convert readily into dc levels. Some qualities of this type are the frequency, the waveform, and the distortion level of an ac signal. Another is the frequency distribution of a complex signal such as the output of an AM or SSB transmitter.

How Can We Measure rf Without Lab Equipment? Any mention of rf measurements, for most people anyway, stirs up immediate visions of highly specialized test gear such as spectrum analyzers, frequency counters, and the like. And let's face it, such equipment is nice to have if you can afford it—but most of us find it hard enough to keep a kilowatt in the shack, and would consider a 5–10 kilobuck outlay on one or two items of seldom-used test gear a needless extravagance.

If one has a spectrum analyzer, a sensitive rf vtvm, a wide-range frequency counter or EPUT (events per unit time) meter, and a good impedance bridge accurate over the entire rf spectrum, and also knows how to use all this gear, measurement of rf (and the special qualities of ac which are difficult to measure with common test instruments) is a snap. Just connect the right gadget in the right way, and read the result off the indicators.

But it's not exceptionally difficult to get the same or even better accuracy in rf measurements with no more test gear than we've already listed as being adequate for dc measurements—a good vom, the station receiver and transmitter, and a well-stocked junkbox.

To show the truth of this statement, let's go down the list of fancy equipment we just set forth and find out what each instrument does, then figure out how to do the same with our restricted set of test gear. We'll start with the spectrum analyzer.

The spectrum analyzer is a device which displays on a cathode ray tube a literal picture of some part of the rf spectrum, as it appears at the input terminal. The horizontal axis of the display represents frequency, and the vertical axis indicates signal strength. If only one signal is present in the band the instrument is set for, the display will be a horizontal line with a single vertical pip on it representing that single signal. If many signals of differing strengths are present, each will be represented by a vertical pip, and the height of the pip will show the relative strength of that signal.

The display looks exactly like the familiar graphs of the spectrum which appear in almost any textbook or magazine article which discusses it, and that's the main thing that makes the spectrum analyzer so convenient to use.

What the gadget actually amounts to, though, is a highly selective receiver with a circuit in it which automatically sweeps the receiver across the selected portion of the spectrum, while sweeping the beam across the crt face at the same speed. The receiver's output drives the vertical deflection plates of the cathode ray tube.

And there's the clue to our cheap-and-dirty version. We don't have to have the tube display. All we really need is to tune a selective receiver across the spectrum, noting down the relative strengths of every signal we encounter. Then we can take pencil and paper, and draw a graph which shows the same thing as the display would.

One of the major ham uses for this type of measurement is to check a transmitter's output for spurious emissions. The spurious emissions may be unwanted sidebands, splatter out of the desired channel, harmonics, or parasitics.

To make such a measurement on a transmitter, using the station receiver set to its most selective condition, the major problem is preventing overload of the receiver. The transmitter should (initially, anyway) be operated at minimum power, and be connected to a well-shielded dummy load rather than to an antenna. Even so, the chances of overloading a sensitive receiver are rather good. To test for possible overloading, disconnect the antenna cable from the receiver. Theoretically, you should not then be able to even detect your transmitter's signal—but few if any transmitters or receivers have this much shielding or filtering included in them. If you find the desired signal, but no others, you can proceed with the measurement; if you find spurious signals even under these conditions, they may be due to receiver overload—and they may actually be present in the transmitter output.

The simplest way to determine whether they are actually present in the transmitter output is to move the receiver to another location, leaving the transmitter operating into the dummy load. Alternatively, enlist the aid of another ham a half-mile or so

away. *His* receiver shouldn't be overloaded by your signal, if your dummy load is a good one (although the chances are fairly good that he will be able to find it). Increase power until his S-meter gives a comfortably high reading on your main signal, but not higher than S9. Then have him search the regions where your receiver indicated spurious signals. If the signals you found were the result of overload in your receiver, he shouldn't be able to locate them. Similarly, if they were actually present in your transmitter's output, they should be equally detectable to him.

If the spurious signals were due to receiver overload, then incase the shielding and filtering of your transmitter, receiver, or both. Most modern transmitters, in these days of potential TVI, have reasonably adequate shielding and filtering. Few hams do. The shielding and filtering required are the same as that required to TVI-proof a transmitter. Details, of course, will vary from receiver to receiver.

In order to describe the measurement technique, let's assume that your receiver passed this initial test and has adequate shielding and filtering so that the only signal you detected was your own carrier. Adjust transmitter power level to provide a convenient reference level on your receiver's S-meter with carrier alone. It need not be high, since it is merely a reference point. The level should be considerably higher than that at which you made the initial test, though, so that if any spurious signals are present in the output they will now be strong enough to be detected.

Now search the regions of the spectrum in which you suspect the spurious outputs might be present. If you find one, keep the receiver tuned to it and increase the transmitter's output until the strength of the spurious signal is equal to the reference level at which you set the carrier initially. Keep track of how much you had to increase the transmitter power to do this. The ratio of new transmitter power to original transmitter power, when converted to dB, will give you an accurate measure of the strength of the spurious signal.

The measurement of strength will be accurate, despite inaccuracies in your S-meter's calibration, because the S-meter is used only as an indicator or reference point, and not to make the measurement itself. To put it another way, the S-meter only tells you when you have increased power enough to make the spurious signal as strong as the carrier was originally. The *measurement* is the comparison of transmitter power in the beginning and transmitter power necessary to bring the spurious signal up to the strength of the original carrier.

Checking across a wide stretch of the spectrum by this technique is a tedious business—but we never claimed it would be quick. It *is* a practical way to check for spurious output, with little test equipment. It can also be used to check the modulation index of an FM signal (by locating the point at which carrier disappears as modulation index is increased), and with minor variations to check both carrier and sideband suppression of an SSB signal.

The station receiver can also double as a sensitive rf vtvm. The rf vtvm is, essentially, an instrument for measuring rf voltages which are very small to begin with. If an accurate measurement of the voltage is desired, an accurate standard for comparison will be necessary—but most uses of rf vtvm are more concerned with the presence or absence of rf voltage at some specific frequency, or its relative strength as some adjustment is varied, and for these no standard is needed.

The procedure for using the receiver as a vtvm is essentially the same as that for making a spectrum analyzer of it. You tune in the signal, and use the S-meter as an indicator of signal strength.

If your receiver has no S-meter, don't let that stop you. Simply connect your vtvm to the avc line (most easily located at the cold end of the first i-f transformer, where a bypass capacitor and isolation resistor should be connected) and measure the relative voltage there. If you have no vtvm, it's still possible to get a fair indication by connecting the vom to measure screen voltage on any controlled i-f tube; unless the screens are fed from a regulated source (and in a well-designed receiver with avc, they won't be, because the variation of screen voltage with avc level helps smooth out the

avc action of the receiver and compensate for some nonlinearities inherent in the design of the tubes) this will give you the desired measure of signal strength. Screen voltage will rise with increasing signal strength, as the avc voltage reduces the tube's cathode current.

The frequency counter or EPUT meter is a bit more complex to simulate with a restricted list of test gear, because its purpose is to measure frequency of an ac signal over a very wide range, and the cheap-and-dirty techniques cover only limited ranges.

A frequency counter consists of several different kinds of circuits. One actually counts the individual cycles of the signal and tallies them up on the visual indicators. Another provides an accurate time reference. Still another acts as a gate, to apply the input signal to the counting circuits for a specified period of time and then to shut it off.

All together, the circuits actually count the number of cycles of the input signal which occur during the time the gate is open, and display the resulting count on a set of indicators. If the input signal is ordinary 60 Hz ac power and the selected time interval is one second, the resulting count may be 59, 60, or 61, depending upon what fraction of a cycle happens to get cut off at the beginning or end of the one-second measurement interval.

Setting the time base to 10 seconds provides an extra digit of accuracy. The indication now will probably be 59.9, 60.0, or 60.1. Going up to a 100-second base adds still another digit, but your power company probably doesn't keep the frequency any more constant than 0.1 Hz either side of the nominal 60.

Most commercial frequency counters offer at least 5-digit readings, but few of them offer time bases longer than 100 seconds. The frequency range usually runs from 1 Hz or so at the low end, up into the VHF region, with time bases as short as a microsecond for measurement of very high frequencies.

To measure frequency in the ham shack, it's not very practical to attempt to duplicate the frequency-counter approach. Instead, we usually divide the ac spectrum into three or four different ranges, and use different techniques for each. For everything except VHF and above, the basic technique is that of comparing the unknown frequency to a known standard.

At audio frequencies, our standards can be 60 Hz ac from the power line, tuning forks, or the 440 Hz and 600 Hz signals broadcast by WWV. Another standard sometimes used is a well-tuned piano.

The ear can be used as a comparison device with surprising accuracy; while few persons have perfect pitch, most of us can tell when two tones differ in pitch—so if enough standards are available, at least one is likely to be fairly close in frequency to the unknown signal.

A variable-frequency audio oscillator can be calibrated by comparison against several standards, and then used as a secondary standard for comparison to the unknown, with the ear still serving as a zero-beat indicator.

Yes, we know a variable-frequency audio oscillator wasn't on our list of equipment—at least, not under that name. But the bfo of the station receiver, together with any source of steady-frequency rf such as the transmitter's oscillator, provides a most handy source of audio tones, and is usually continually variable throughout the audio range!

To increase accuracy of such measurements, a scope can be used as an indicator of zero-beat rather than trusting the ear. Just connect the scope's vertical input leads across the variable audio oscillator's output, and the horizontal input leads to the unknown signal. If the two signals differ in frequency, the tube will display a pattern of varying complexity. When the frequencies become identical (zero beat), the pattern will be either a straight line, a circle, or an ellipse. If it's an ellipse, it may appear to be rotating, and shift through the circle and straight-line conditions as it rotates. This indicates a very slight difference in frequency; the difference in cycles per second is equal to the number of times per second the pattern rotates. Keeping this in mind, it's easy to measure a *difference* of as little as 0.01 Hz in the two frequencies; whether the

final frequency measurement has this accuracy will be determined entirely by the accuracy of the standard you're using.

When the unknown frequency is above the audio range, the same basic technique is still used but the source of frequency standards differs. A standard-frequency crystal oscillator is handy to have in this case; refer to your junkbox and rig one up. Zero-beat it against WWV, using the af measurement technique to get as much accuracy as you can. You now have a source of rf of known frequency—the usual standard is 100 kHz.

The frequency of the unknown signal is first approximated by comparison to other signals of known frequency. Then you turn on the frequency standard, and count harmonics of it from some known point. An easy point for most of us to locate in any ham band is the lower band edge; this is also, always, a harmonic of 100 kHz, and so when the receiver is tuned approximately to the lower limit the harmonic of the standard will mark the exact band limit. Other known points in the spectrum may be located in the same manner—if necessary, by counting multiples of 100 kHz from the nearest ham band.

The 100 kHz standard permits the unknown signal to be bracketed between two points 100 kHz apart, and it's usually not too difficult to determine which of these two it's closest to. This locates the frequency of the unknown signal to someplace inside an area 50 kHz wide; for many purposes this is close enough. If not, we call upon a second frequency standard. This is a multivibrator or frequency divider, slaved to the 100 kHz unit, which provides a 10 kHz signal as accurate as the 100 kHz original. By switching it on, and counting harmonics as we tune up from the known 100 kHz harmonic, we can bracket the unknown signal between two 10 kHz harmonics of known frequency.

If even this isn't accurate enough, we're not done. The 10 kHz frequency is within the audio range, and we've bracketed our unknown between two of these points so the error in our measurement this far cannot exceed 5 kHz. All we need do is measure the beat frequency between our unknown and the nearest 10 kHz harmonic (that is, the lowest frequency in the receiver's output), using audio measurement techniques, to locate the unknown frequency to an accuracy limited only by that of our standard.

This technique for measuring rf frequencies works equally well from the bottom of the rf region up to the VHF area; as frequency increases, the number of 100 kHz harmonics becomes a bit large so that VHF workers customarily use still a third standard oscillator set to 1 MHz to obtain a good starting point, but the technique remains basically unchanged.

By the time we get to 50 MHz or so, however, the strength of the 10 kHz harmonics is getting a bit weak. Somewhere in this region, most of us switch to a completely different measurement technique which depends upon the constant relationship between frequency and wavelength. Rather than measuring frequency in terms of time, it becomes easier to measure wavelength in terms of distance.

For this, we use what are known as Lecher wires. The term presumably has nothing to do with dirty old men. A set of Lecher wires consists essentially of a parallel-wire transmission line which is at least one wavelength long. For 50 MHz use, that's just under 20 feet. One set will suffice for all measurements. In addition to the two taut parallel wires of the transmission line, which must be uninsulated and supported only at their ends, we have a shorting block which shorts the two together and which can be moved the length of the wires, and a connector at one end to connect the wires to the transmitter output. Often, the shorting block includes some indicator of rf current such as a pilot lamp. In another version of Lecher-wire technique, the short is left permanently in place at one end of the wires and the transmitter is connected to the other end; in this case, an indicator of rf voltage is arranged so that it can be moved the length of the wires to measure voltage between the two conductors at any point along their length.

The idea behind the Lecher wires is that every condition which exists on a transmission line will exactly repeat itself every full wavelength down that line, and many conditions such as peak absolute voltage

(without regard to phase) will exactly repeat every half-wavelength.

Thus if a transmitter is coupled to a set of Lecher wires with the shorting bar set at the far end, and adjusted for a specific amount of plate current at resonance, and then the shorting block is moved closer to the transmitter, the conditions under which the transmitter's output stage operates will change as the shorting block moves. When the block has been moved exactly a half wavelength, however, the conditions will have returned to the exact duplicate of those at the start, and the plate current will again be what it was at the beginning. Simply measuring the distance through which the block was moved and multiplying by two tells us the wavelength; converting wavelength to meters and dividing the result into 300 gives us the frequency in MHz.

As described, the Lecher wires can be used only to measure frequency of a transmitter, and that is their most usual use. They can, however, be used as a tunable trap to trap out the signal, and thus can be used to measure frequency of signals other than those produced by a transmitter—if you have a receiver capable of detecting the signal being measured. The technique is similar; the signal being measured is coupled to the receiver, and the Lecher wires are connected in parallel with the receiver input. The receiver S-meter, or a similar indicator rigged up as we discussed earlier in connection with rf vtvm's, is used to indicate signal strength. At some positions of the shorting bar, signal strength will reach maximum, and at other positions of the shorting bar, signal strength will be minimum. The distance between two points of either maximum or minimum strength will be a half wavelength; you can use whichever is easiest to detect.

The impedance bridge is a device for measuring the impedance of any circuit at any specific frequency, and this is the hardest of all the lab-type instruments to duplicate in a cheap-and-dirty version with limited test gear. Fortunately, its major use for ham purposes is in the matching of antennas to transmitters and feedlines, and this application can be simulated by simple measurement of swr on the feedline.

To measure swr on a feedline, locate a point on the feedline at which the rf voltage is at a maximum. This is simple with open-wire feedlines and not too difficult with twin-lead, but coax poses a difficult problem not easily solved. When the rf voltage maximum is located, if the frequency is known you can find the voltage minimum point a quarter-wavelength in either direction from the maximum point. The vswr is simply the ratio of maximum voltage to minimum voltage.

At sufficiently high frequencies, a variant of the Lecher wires can now be used to adjust the swr to unity. This consists of a length of open-wire transmission line with an adjustable short, at least a half wavelength long, which is connected across the load (or, alternately, at some multiple of half a wavelength back from the load). By moving the short along this line, the swr can be changed to anything from unity to infinity. The principle is that the impedance of the "tuning stub" changes from zero to infinite as the shorting stub moves through a quarter wavelength distance, and is either capacitive or inductive, depending on whether the stub's effective length is greater or less than a quarter wavelength.

When the stub is adjusted to bring swr to unity (1.0 to 1), then the impedance of the stub is exactly canceling any reactance in the load itself, and the resistive element of the stub's impedance is bringing the load's resistance to a match as well. The impedance of the stub can be calculated from its length, and a bit more calculation will reveal the impedance of the load.

This technique is actually that employed in most microwave labs; instead of a "tuning stub" they call the adjustable element a "slotted line," and they perform the calculations graphically by means of a "Smith chart." The result is the most accurate measurement now possible of rf impedance at very high frequencies—but it's more trouble than most of us find convenient.

Why Use An Oscilloscope? You may recall that our list of minimum test equipment did not include an oscilloscope, yet the scope is one of the most convenient of all test instruments to use and many hams working with RTTY or sideband feel that

the scope is as indispensable as a receiver or a transmitter. Let's examine the instrument in detail and find out why it's so convenient.

An oscilloscope—any oscilloscope—is built around a cathode ray tube. In addition to the tube itself, the scope includes power supplies. Most scopes also include amplifiers to drive both the vertical and horizontal deflection plates of the tube, and a horizontal-sweep circuit of some type to provide a "time base."

The differences between scopes are, for the most part, differences in the deflection amplifiers and in the horizontal sweep circuitry. An inexpensive "general-purpose" or "service" scope typically has a vertical deflection amplifier with frequency response from the subsconic up into the low rf region (5 Hz to 500 kHz, frequently), a horizontal amplifier with more restricted bandwidth, and a sweep oscillator which provides a sawtooth waveform from 15 to 20 to 200,000 pulses per second.

More expensive "service" instruments often provide a vertical-amplifier frequency response from dc up to 4 or 5 MHz, to provide the capability of viewing all key waveforms in a color-TV chassis.

"Lab-type" scopes are more elaborate; they may provide amplifiers with frequency response from dc up to 50 or 100 MHz, with much more accurately calibrated "triggered-sweep" or even "delayed sweep" time-base circuits. The "X-Y" scope has identical vertical and horizontal amplifier circuits. There are almost as many variations as one can imagine.

But while the variations among scopes lie mainly in the associated amplifiers and time bases, the heart is the cathode ray tube itself; it provides the characteristics which make the scope useful.

Like any other vacuum tube, the cathode ray tube (crt) contains a heater, a cathode, and a grid. But there the similarities end. Instead of a plate, the crt contains several additional electrodes known as "focus" electrodes, and an "accelerator" electrode. In addition, the crt's used in most scopes contain two pairs of "deflection plates." And finally, the "face" of the tube is coated on the inside with a "phosphor," which is a substance that glows when struck by rapidly moving electrons.

The heater brings the cathode to a temperature which permits electrons to boil off its surface, and these electrons are attracted toward the focus and accelerator electrodes, passing through the grid structure en route.

However, the shapes of all these electrodes are such that the electrons—at least, most of them—never reach either the focus electrode of the accelerator directly. Instead, the same electric forces which attract the electrons away from the cathode shape the stream of electrons into a tight beam, which passes through appropriately shaped openings in the focus and accelerator electrodes and goes on to strike the phosphor at the tube's face.

Once the electrons hit the phosphor, they can bounce back in all directions inside the tube and thus make their way to the accelerator, completing the electric circuit. When the electron beam strikes the phosphor, though, it creates a glow where it hit—and that's the whole purpose of the crt in the first place.

The intensity of the glow depends on the number of electrons which hit the screen (phosphor), and this is in turn controlled by the grid-cathode bias of the crt just as in a conventional vacuum tube.

The physical size of the beam depends upon the balance of the forces which shape the beam in the first place, and so is affected by many things. The beam intensity, the speed at which the electrons are traveling, and the relative voltages between focus electrode and cathode and between focus electrode and accelerator all have some effect upon beam size. The major control of beam size is the voltage present between focus electrode and cathode. If the other factors are in the right general area, the voltage on the focus electrode can be adjusted to shape the beam into the smallest possible physical size—or, by analogy with optics, to "focus" the beam to an apparent point.

The speed at which the electrons in the beam are traveling is determined by the voltage between accelerator and cathode. The greater the voltage, the faster the beam.

Since the electrons are packing more energy when they move faster, this will also affect beam intensity. Most crt's operate with voltages of 1 to 25 kV between accelerator and cathode; typical values for a 5-inch crt would be about 2000 volts. The high voltage is required because of the physical distance between cathode and accelerator, and also in order to establish the proper "electron ballistics" to permit focusing action. While the voltage is high, the current is very small, normally being in the microampere range.

The combination of heater, cathode, grid, focus, and accelerator is known as an "electron gun." The electron gun supplies a steady stream of electrons in a nice tight beam, but all that does on the screen is produce a single intense dot of light. For the tube to serve any useful purpose, that dot must be moved about on the screen and that's the purpose of the deflection plates.

The two pairs of deflection plates are arranged at right angles to each other, so that the beam passes halfway between the two plates of each pair on its way from electron gun to screen (some crt's use "postdeflection acceleration," with an additional accelerator between deflection plates and screen, but this is a complication we won't go into here; the principles are similar).

The electrons in the beam are, of course, negative charges, and are subject to the laws of electrostatic attraction and repulsion. Thus, if one plate in a pair is made positive with respect to the beam, the beam will be attracted toward that plate. If the other plate goes negative at the same time, the beam will be repelled from the negative plate and attracted toward the positive one. By independently adjusting the voltages on each pair of plates, the beam can be moved to any desired location on the crt screen.

In practice, both plates of each pair are usually kept at approximately the same voltage, which is usually 150 to 300 volts more positive than the accelerator. To keep things within reasonable limits, many scopes have the crt hooked up so that its cathode is 2000 volts negative with respect to ground, its accelerator is at ground level, and the deflection plates are 200 to 300 volts positive to ground. This permits direct connection from the deflection amplifier plates to the deflection plates of the crt for better low-frequency response, and all the high-current voltages are kept to moderate levels. In such a hookup, the deflection plates are still around 2200 volts positive with respect to the crt cathode, however. The exact ratio of voltages between one plate and the other of each pair is adjusted as necessary to put the electron beam in the center of the screen with no signals applied; this is the purpose of the "centering" controls on the scope.

The signals to be displayed on the scope are then applied to the deflection plates, and thus move the spot around the crt screen in a manner determined by the waveform and intensity of the signals. If a sine-wave signal is applied to the vertical plates while a sawtooth signal is applied to the horizontal plates, the resulting spot movement will trace a conventional "picture" of the sine-wave on the screen.

Like the more conventional dc meter movement, the scope changes an electrical force into visible movement of something. Where the ordinary meter moves a pointer which has considerable weight and limited speed of response, however, the scope is moving an electron beam which has, for all practical purposes, no weight or inertia at all and so is capable of almost unlimited response speed. An ordinary dc meter cannot follow the fluctuations of a 20 Hz signal rapidly enough to be read conveniently; an ordinary scope can easily display variations in a 50 MHz signal, if its deflection amplifiers are bypassed and the signal connected directly to the deflection plates.

This rapid response, and the ability to draw waveform pictures which correspond to the way most of us imagine waveforms, are the two features that give the scope its chief value. There's something about actually *seeing* a signal that no amount of indirect measurement can provide.

We've already mentioned the use of the sawtooth or "time base" horizontal sweep for waveform viewing, but the scope is equally useful as a direct comparison instrument. If one signal is applied to the vertical plates and another signal to the horizontal plates, the resulting display on the screen

will be an instantaneous comparison of the two signals. If one signal is an unknown frequency while the other is the known standard (or, better yet, an adjustable-frequency secondary standard), the screen display will provide an indication of the relationship between the two frequencies. If the display is a stationary pattern, the unknown is an exact harmonic of the standard or vice versa; at any rate, one of the frequencies is an exact multiple of the other. If the pattern moves, the relationship is not exact.

The signals being compared do not have to be completely separate signals. A signal can be compared against itself. If the same signal is applied to both the horizontal and the vertical plates, the screen display will be a single line inclined at a 45 degree angle from the horizontal. If the vertical plates are fed by the signal from the output of an amplifier's input, the display will show the effect of the amplifier on the signal. Since the amplified signal is stronger than the input signal, the vertical deflection will be greater than the horizontal and the display will be moved nearly vertical. If the only thing the amplifier does to the signal is to amplify it, this will be the only difference in the displayed signal. If the amplifier also introduces distortion, though, the vertical plates will get the distortion components of the signal and the horizontal plates will not—and the display will no longer be a straight line! Instead, it will show "squiggles" indicating the presence of distortion.

If the amplifier changes the phase of the signal, the display won't be a straight line either—instead, it will be an ellipse or a circle (which depends upon the amount of phase shift introduced by the amplifier).

Since this comparison is essentially that of a signal against an amplified version of itself, it can be used at any frequency to which the deflection plates can respond. In practice, this means any frequency below the UHF region.

If linearity of an rf amplifier is being checked by this method, though, it's often more convenient to modulate the rf, then use detectors at both the input and output test points to convert the modulated rf to audio and make the actual comparison on the audio components rather than the rf itself. When this is done, the scope's internal amplifiers can be used, and the effects of the amplifier's gain canceled out by amplifying the input-side signal a corresponding amount more than the output-side signal. This often makes the distortion easier to see, since it is normally very small in comparison to the original signal level.

What are dB? It's almost impossible to do anything in radio any more without running into "dB," the abbreviation for "decibels." It's also almost impossible to find anyone capable of giving a brief yet clear and accurate description of what these beasties really are. Let's give it a try, anyway.

The word "decibel," itself, is the standard metric-system indication for a unit of measurement which is one-tenth of a "bel." This doesn't help much, because even fewer persons are familiar with "bels."

The "bel" is the unit of power ratio, and simply indicates a 10-to-1 power ratio. A 100-watt amplifier is one "bel" more powerful than is a 10-watt unit, and similarly the 10-watt unit is one "bel" more powerful than a 1-watter.

This makes it appear that a 100-watt rig would be only two "bels" more powerful than a 1-watt outfit—and that's exactly right. Each "bel" indicates an additional 10-time increase in power, so that two "bels" means 10 times 10 or 100 times as much power.

It only takes six "bels" to make a million-time power increase. Sailors who are used to the expression "eight bells and all's well" would be floored if they were talking about "bels" instead of "bells," because that's a power ratio of 100 million to 1.

Obviously, the "bel" is far too large a unit for comfortable use. That's why "decibels," which are only one-tenth as large, are the unit in common usage.

It might appear that, since a decibel is 1/10 of a bel and a bel is a 10-to-1 ratio, a decibel would be 1/10 of 10-to-1 or simply a 1-to-1 ratio. However, that's *not* the case, and the reason is far from obvious. It comes about because of the way in which the ratio is converted into a number to make the "bel" unit in the first place. To get one "bel" from a ratio of 10, or two "bels" from

a ratio of 100, what we really did was simply count the zeros in the ratio. The number "10" has one zero, so that's one bel. Similarly, 100 has two zeros, so it's two bels. A million is written as "1" followed by six zeros, and so it's six bels. And so forth.

This business of counting the zeros is the first step of the mathematical process called "taking the logarithm" of a number. If the number happens to be an even multiple of 10, it's also the last step of the process as well—but if it's not, there's much more to it. The "bel" is thus defined as the *log* of the power ratio.

When we stepped down from the massive "bel" to the more conveniently sized "decibel" we applied our factor of 1/10 to the *unit* itself, not to either the ratio of the log of the ratio. The bel is still what it always was; it just takes 10 times as many decibels to make a bel. Since the bel is the log of the power ratio, this means that 10 dB = log (P1/P2). One dB, then, would be 1/10 of log (P1/P2); we usually write this equation a little differently. We turn the ratio upside down so that the log gets multiplied by 10 rather than divided, and come out with the formula you'll find in all the textbooks: dB=10 log (P2/P1).

We've made this brief excursion into "logs" and equations just to show where the formula came from. In actual practice, you don't need slide rule or log tables to work with dB to as much accuracy as is ever needed in any radio work.

All you need is the knowledge that an additional 10 dB is a 10-time power increase, 100 dB is 100 times, etc., plus a knowledge of the ratios indicated by each dB value from 0 through 9. Even of these 9 ratios, you'll normally use only a couple.

The ratio for zero dB is 1 to 1. If an amplifier is rated for 0 dB gain, its gain is exactly one. To see this most easily, convert the dB back to bels for a moment. Ten times zero is still zero, so 0 dB equals 0 bels. The number of bels, we recall, is equal to the number of zeros following the "1" in the power ratio. One followed by no zeros remains one, so the ratio is 1 to 1.

The most important dB-to-ratio number to remember is that for 3 dB. This is a 1.995-to-1 power ratio, which is so close to being 2-to-1 that nobody ever pays any attention to the difference. Remember it as 3 dB equals twice the power.

Back at the beginning of this question, we saw that *adding* dB (or bels) is the same as *multiplying* the power ratio. It follows, then, that 6 dB should be just barely less than a 4-to-1 ratio. The actual ratio is 3.931 to 1, but 4 to 1 is close enough for any practical work again.

A single dB is a ratio of 1.259 to 1; the easiest way to remember this is as 5-to-4 ratio, or 1.25 to 1. You don't really need to remember it, except that it gives you the ability to figure out the ratio for any other number of dB.

For instance, working from the 5/4 ratio for 1 dB, we would get ratios of 25/16 for 2 dB and 125/64 for 3 dB.

Let's see what happens when we use both the 3 dB and 1 dB values this way to calculate the ratio for 10 dB (which we already know is really 10 to 1): To tally up 10 dB from our 3 and 1 dB figures, we get 2x2x2x(5/4). This comes out to 40/4, or exactly 10 to 1. The small errors in both the 2-to-1 figure and 5-to-4 figure have canceled each other out.

If we did it with nothing but the 1 dB figure, we would multiply 5/4 by itself 10 times. This comes out to be 9765625/1048576, or a ratio of 9.3+ to 1. In this case, our error has accumulated a bit. The moral is clear; when you figure out the other values, use both the 3 dB and 1 dB values to keep the error to a minimum.

Now let's use these facts we have memorized to find out the power ratio indicated by 37 dB. First, we dissect the number "37" into its components, 30+3+3+1. The "30" gives us a ratio of 1000/1. Each "3" gives us a ratio of 2/1, and the "1" gives us a ratio of 5/4. The total "37" must, then, mean a ratio of 1000/1 times 2/1 times 2/1 times 5/4, or 4000/1 times 5/4, which works out to be 20,000/4 or 5000/1. An amplifier rated for 37 dB gain would, then, produce a power ratio from output to input of 5000 to 1. A hundredth of a watt at the input would produce 50 watts at the output.

You may have noticed that we've only looked at positive dB figures. Often, ratings

are expressed in negative dB. While it's just as easy (or difficult, as the case may be) to work the math for negative as for positive logs, the simple way out is to always think in terms of dB without sign, and then read the sign as meaning "gain" or "loss." Positive dB indicate gain and negative dB indicate loss. An attenuator rated for −37 dB from input to output still involves a 5000/1 power ratio, but now it's in the other direction and the output power is only 1/5000 as great as that at the input.

"Great," we can hear you mumbling, "but what about dB of voltage or current? All you've mentioned yet have been *power* dB, and most of the time we use the other kind!"

Relax. There *is* no other kind. Decibels, *any* decibels, always indicate power ratio. Granted, the textbooks show you a different formula if you're dealing with voltage or current measurements—but that's just to keep you from having to convert the voltage or current into power by using Ohm's law before making the dB conversion.

And since that "other" formula—the one that says dB=20 log (E2/E1)—*is* a combination of the dB formula, the power equation P=E x I, and Ohm's law all wrapped up in one package, it can get you into big trouble with the kinds of questions the FCC puts on its exams.

If, on the other hand, you fix firmly in mind that dB are measures of power ratio and nothing else, you can't go wrong. If the problems fails to mention power and gives you either current or voltage instead, just convert the current or voltage to a power by plugging it into the power equation. Then use the decibel relationships we've already examined.

Many times, both on exams and in practical work, you may find that only a voltage or a current is given; there's only half the information you need to figure out the power. What then?

If the two voltages being compared are both being measured across the same (or equal values of) resistance, you can get the power by squaring the voltage and dividing by resistance. This is just a combination of the power equation and Ohm's law; Ohm's law tells you the current given the voltage and resistance, while the power equation tells you the power when current and voltage are known.

As a matter of fact, this can be done even when the resistance values differ! And when the resistance values are equal or the same, you don't even have to know what the resistance is, because when you take the ratio of the two power figures, the resistance will cancel itself right out of the calculation.

That means that all you have to do is use the *square* of the voltage in place of the power figure, and everything we've said about dB will still hold true. But this will work *only* if both voltages are measured across the same resistance value; if the input voltage is measured across one value of resistance and output voltage is measured across some other resistance value, then all bets are off. For example, you might measure 1V at the input of an amplifier across a 1-megohm resistor, and find 1V at the output across a 10-ohm load. If you simply work with the voltage ratios, you have 1/2 or 0 dB ratio. But 1V across one megohm is just a microwatt (1/10000000 watt), while 1V across 10 ohms is 1/10 watt, so the amplifier itself must have a power gain of 100,000—which is 50 dB!

In the one very special case of identical resistances, however, the ratio of the squares of the voltages can be used in place of the power ratio; now as it happens, one of the nice properties about log-type numbers is that the log of the square of any number is just two times the log of the number itself. Similarly, the ratio of the squares of two numbers is exactly the same as the square of the ratio of the two numbers—you can take the ratio either before or after squaring, so long as the end result gets both the input and output voltages squared. That means all we have to do to the "power" or universal version of the dB formula is plug in "E" instead of "P," and multiply by two—which is where the "other" formula applies only to a single special case, while the "power" version applies to everything.

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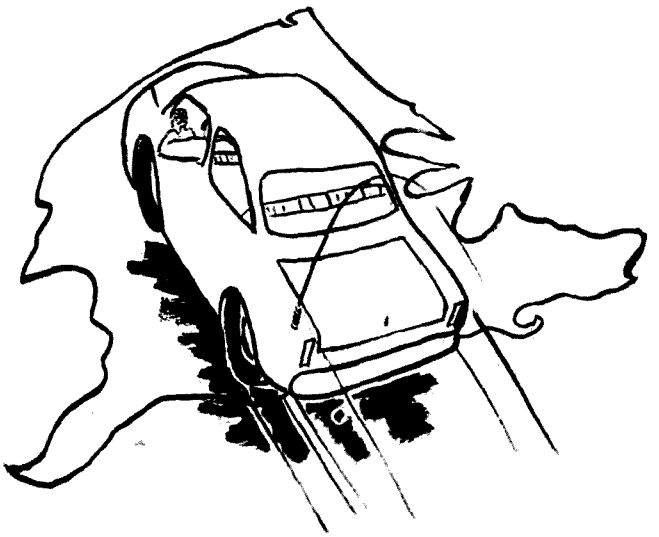
VHF FM & ...YOU

Why has this mode made such a sweeping impact on amateur radio?

The past few years have shown a marked increase in the number of amateurs operating on the 50 MHz, 144 MHz, and higher frequency bands. Many of these amateurs are using surplus or obsolete commercial FM equipment. This rise in FM activity is due to several factors, including the availability of equipment and the need for reliable single-frequency communications. The availability of equipment is due to two prime factors: The "splitting" of commercial FM channels has rendered many older units unsuitable for commercial use. Also, recent trends in miniaturization have made many units obsolete in terms of size, reliability, and battery-power consumption.

The need for a reliable single-channel system stems from several factors: The

average American is much more "mobile" than ever before. In previous years of amateur radio operation, people in certain



The average American is much more mobile than ever before.

areas monitored specific frequencies. Since almost everyone was using AM, close receiving and transmitting tolerances were not required. Today, with the accuracy needed for monitoring and transmitting on specified SSB frequencies, it is becoming less and less popular to do so. Of course, there are a few frequencies that are monitored in certain areas, but these are relatively rare. Also, the congestion on the lower frequencies is increasing, thus requiring more and more power in both mobile and fixed-station equipment.

The trend is thus towards a universal fixed-frequency type of operation in cases where reliability and performance are required. This has been met by using certain specified frequencies and fixed-frequency FM equipment. The most popular of the universally accepted VHF frequencies are 52.525 and 146.94 MHz.

Operating on VHF FM

Operation of VHF FM is very much like operation on the lower frequencies, and yet it is very different. It is like AM, SSB, and even CW in that there is much ragchewing, many technical discussions, and even emergency and traffic nets. You can call your buddy, check out equipment, and handle traffic and emergency situations. It is quite unlike SSB, AM, and CW in that there is no need to retune the transmitter and receiver every time you operate; there is usually no background noise whenever the frequency is not in use (almost every piece of commercial FM gear has a noise-stopping squelch); high power is not needed for general use; and the frequency is almost constantly monitored.

Although the sudden popularity of FM and the increasing availability of specially designed gear threaten to change the picture, the equipment used by the average FM'er has typically been obsolete commercial equipment previously used by police, fire, taxi, utility, and other groups. This equipment has a power *output* of from a few milliwatts to nearly 100 watts, and a frequency selection of from one to four crystal-controlled channels. The design of the equipment is excellent. The receivers often have sensitivity figures of 0.5 μV (for 20 dB of noise quieting) or better. Operation of the equipment is quite simple, for it was originally designed to be used by nontechnical people in business or emergency situations. The controls usually consist of an on-off-volume control, a squelch control, and a push-to-talk microphone.

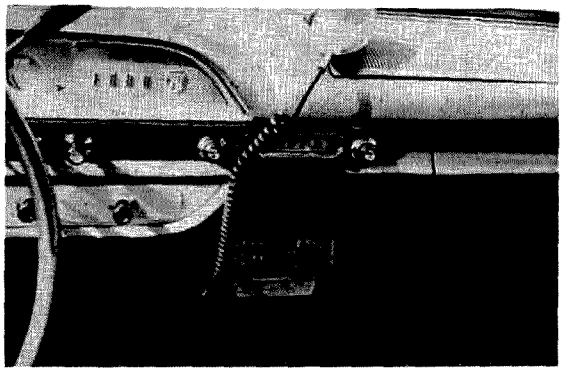
Many amateurs operate using "wideband" or ±15 kHz deviation. Some amateurs in certain areas are gradually shifting to "narrowband" or ±5 kHz deviation. This poses no real difficult problems, for narrowband signals can be received on wideband equipment (with an apparent loss of audio volumeand subsequent decrease in signal-to-noise ratio). Wideband signals can rarely be received on narrowband equipment without adjustment of the transmitting or receiving equipment, however.

Almost every metropolitan area now has at least one repeater system which will pick up and rebroadcast signals. In most cases, the input of these repeaters is 146.34 MHz and the output is 146.94 MHz. But in areas of extreme spectrum congestion, other frequency pairs are used.

The range of units (without using a repeater) varies with terrain and power output, as well as the type of antenna used. It has been my experience that the average unit now in use by the amateur FM'er (10W

output with a quarter-wavelength whip) has about a 15-mile range of communication.

FM equipment is generally reliable, and when it does become necessary to either repair or service, it is relatively easy to work on. Many units use common tube types in both the receiving and transmitting portions, thus eliminating a parts scarcity problem. Most units are divided into three distinctive portions: transmitter, receiver, and power supply, with interconnecting cables. These "strips" are often interchangable between units, from base station to mobile and from mobile to base station. Trunk mount units are usually "wife approved," for the control



head and speaker take up very little room in the car. However, there is very little difference in performance of trunk mount and dash mount units of the same type.

Acquisition of Equipment

The old Bugs Bunny cartoons used to start with Elmer Fudd reading a recipe for rabbit stew. He would quote the first instruction as "First, catch a wabbit." Well, the first instruction in the recipe for good amateur FM'ing is to first catch the unit.

Local sources of equipment vary. The best place to start is another amateur who is already active on VHF FM. Many FM'ers keep spare units around for trading and helping out newcomers. If you don't know any active FM'er in your neighborhood, then you will have to start looking elsewhere. In some localities the police and fire forces are possible sources. However, many departments either trade in older equipment on newer models, or they sell the units to the members of the department for monitor receivers and for auxiliary squad work.

Another possible source is taxi companies. The two-way radio is the life-blood of the taxi driver, so most cars are usually equipped. Herein problems also lurk. Many taxi companies trade in older units or sell them to the individual drivers. The units sold to the drivers often get resold to other



Many taxi companies trade in older units or sell them to individual drivers; but the units often get passed along more than once, and they come out the worst for wear in the shuffle.

drivers and so on until the unit is either so old or so beat up that it is good only for a boat anchor.

The modern railroader is quite dependent upon communications, so FM gear is found around rail yards. Railroading is hard business, and the equipment often sees rough service. However, many amateurs have been able to obtain obsolete equipment from railroads. If there is a repair center in your area, check with the purchasing agent there. If not, talk with someone who works for the railroad and find out who takes care of the radios in your locality.

Sometimes two-way radio repair shops are subcontractors to the major manufacturers and some even buy and sell two-way equipment. However, many of these shops

have a market for monitor receivers, system spares, and the like, and do not like to dispose of any extra pieces of equipment at low prices. There is always a chance, though, and even if the personnel do not have any units to dispose of, they often have information as to where such units can be obtained.

Utility companies usually buy equipment from the two-way manufacturers on an outright basis and seldom trade in older equipment. Often entire fleets of equipment are retired at the same time. Some companies will sell one or two units at a time while others will only sell in lots of 5, 10, 15 or more units. In these cases it is necessary for a group or club to purchase the units in order to meet the minimum purchase requirements. Of course, some utility companies have been known to give the units to a club for distribution to the membership – but such cases are the exception.

It is possible to purchase either portions of units or complete systems from companies who specialize in the surplus FM



market. These may be found by looking through the pages of this issue of 73. However, the prices are usually higher than would be paid if obtained locally. One advantage of dealing with a surplus house is that you have some recourse if you're not happy with your purchase within a reasonable period. Several of the surplus FM suppliers offer money-back equipment guarantees. Also, these companies often have a supply of schematics and other information on the equipment.

If you have a selection, always pick a mobile with a transistorized power supply over a vibrator (and a vibrator over a dynamotor, if in the same power output class). Always remember that power output is the measure of FM gear, not power input as in other equipment. If the unit is intended for fixed-station use, pick out the highest powered unit in best condition. If a choice is available between several units pick the newest type.

General Conversion Techniques

The first step in conversion is to determine the frequency range of your unit. If the source is known, it is a simple matter to check the operating frequency. If the source is not known, a look at the final tank will usually give a clue. Of course, the major manufacturers have a definite system of marking the frequency ranges of the equipment.

The first step in the actual conversion is to acquire a set of crystals on the proper frequency. This is best accomplished by ordering commercial grade crystals from a crystal company that typically supplies crystals to the two-way industry. I highly recommend International Crystal for several reasons: They can supply crystals of the correct cut and frequency for multiplication when given the manufacturer of the equipment and the manufacturer's crystal type; International guarantees crystals for correct operation; and they give excellent service in terms of turnaround time and warranty replacement. Regardless of the source of the crystals, it is important that they are of the correct cut. If the crystal was not designed for the oscillator circuit used in the equipment, it may not "pull" onto the correct frequency if it oscillates at all.

The next step is getting the heater strings on the correct voltage. If the unit is to be used as a base station with an external ac supply this step is unnecessary, for the correct heater voltage can be supplied from the ac supply.

Many 6V units have the heater strings divided into two 6V sections with approxi-

mately the same current requirements for each section. If this is the case, conversion to 12V involves merely lifting the ground side (if any) on one half of the heater strings and forming a series–parallel arrangement. It is necessary, however, to retain a balance in current requirements. That is, do not put a section requiring 5A of heater current in series with a section requiring 6.5A, etc. A small difference can be tolerated, but the better the match, the better the performance. In units where the "strings" do not exist, it is necessary to calculate the heater current requirements and then develop the necessary series–parallel arrangement.

The power supply is the next area of conversion. Fortunately, most transistorized power supplies are found in either 12V only or 6/12V combination units. Thus, I will not attempt to cover them here. Dynamotor units may or may not prove to be difficult to convert from 6 to 12V operation. The cheapest method is to replace the dynamotor with a 12V surplus unit. The DM-35 works very well in higher powered units (50–60W), and other units may be used for lower powered equipment.

The receiver power supply is almost always a vibrator supply, even in dynamotor units. The simplest modification for this supply is to pick up 6V across one of the filament strings. A 2W dropping resistor of 20–47Ω will have to be put in series with the vibrator coil if the vibrator itself is driven directly from 12V.

Vibrator units are generally of two types: Lower powered units (<15W) use a single transformer to provide voltage for both receiver and transmitter B+ lines. Higher powered units use two transformers, one for low B+ and one for high B+. In the case of the single transformer unit, the power supply may be connected across the lower leg of the heater string. In this case, allow for the current required by the power supply when setting up the heater strings or place a resistor of the correct size across the other heater string. In the case of two transformers, each one may be placed across separate heater strings. Make sure that the circuitry formerly grounded goes to the 6V point in the section which is connected

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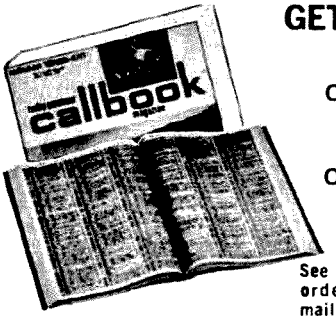
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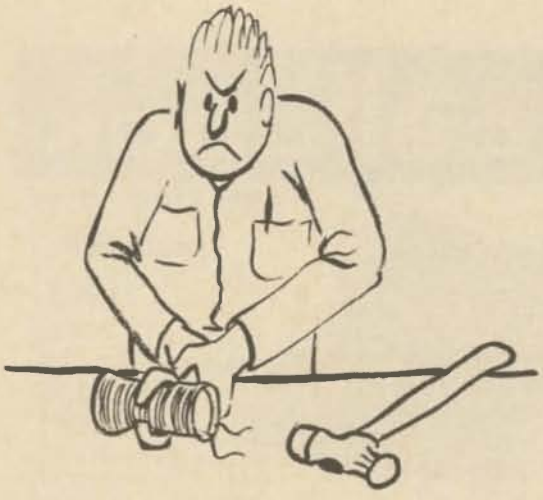


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across the "high" heater string (the string which is not grounded).

The rectifiers used in older FM equipment are usually of the selenium type. If higher voltage is required, or if any one of the rectifiers is defective, replace the entire rectifier with the silicon type. This usually results in higher transmitter output and lower power supply heating.

Low-band conversions. Units which were originally designed for the 25–30 MHz range will, of course, work on 10 meters without any modifications. The only thing which needs to be done is to put in the necessary crystals and keep the deviation below the maximum allowed by the FCC. Units designed for the 30–40 MHz range will also usually work on 10 meters without modification. If the receiver will not tune down to 29 MHz, it is usually necessary to place small capacitors (a few picofarads will usually do) across the coils in the rf section. The transmitter final grid and tank coils may be slightly squeezed together to lower the frequency.



The transmitter final grid and tank coils may be slightly squeezed together to lower the frequency.

Use of the 30–40 MHz units on 6 meters sometimes requires a substantial amount of modification. Fortunately, only the rf and first mixer sections need modification in the receiver. These coils must be reduced by either removing turns or decreasing the capacity across the coils. A grid dip oscillator is a must. The entire transmitter section must be modified. Each coil must be reduced in size until it will tune to the correct frequency.

The 40–50 MHz units can be used on 52.525 MHz without modification. All that is required is the proper crystals. If, for some reason, the unit will not tune up to 52 MHz, it may be necessary to reduce the capacity across the receiver rf coils and slightly spread the turns of the final tank coil to bring them within the tuning range.

High-band conversions. Units in the 144–170 MHz range will usually tune up on 146.94 MHz without modification. Units that require modification can usually be brought within range in the following manner: The receiver rf coils may be padded within range by putting small Mylar capacitors of 2–5 pF across each section. The receiver oscillator coil may require as much as 20 pF across it. (Try for proper operation without this capacitor before adding it.)



The only transmitter stages usually requiring modification are the driver and final sections. The driver may be brought within range by either squeezing together the turns of the coil (if a coil is used) or by the addition of approximately 5 pF across the tuning capacitor (if parallel lines are used). In the cases where there is not enough capacity in the final tank circuit or where adjustable plates do not exist, it is necessary to add capacitance here also. The simplest

manner is to make a capacitor from about 3 in. of RG-58/U coax. This coax is attached with the shield side to one line and the center to the other. The coax may be trimmed about ¼ in. at a time until the final tank is resonant with the tuning slider about ¼ in. from the end.

General tuning instructions. For the most part, the FM unit is tuned in each stage for maximum output. Most equipment has either a central metering point or a test jack for each stage. In all cases a VOM may be used as a visual indication. Normally a 0–3V scale is sufficient. The Motorola units may be measured with either a VOM or a 50 μA meter. Generally, the only exception to the "maximum output" rule is the discriminator frequency, which is adjusted for a zero reading.

The receiver should be tuned starting with the meter at the second limiter test point. As the tuning progresses, it will become necessary to first reduce the signal input to the receiver and then to switch to the first limiter test point. As the second limiter approaches saturation, the reading will begin to decrease, thus giving a false reading. That is why it is necessary to reduce the signal input. The same thing holds true for the first limiter, but it does not go into saturation as easy as the second limiter and is therefore a better indication at higher signal levels.

When starting from scratch it is usually necessary to begin receiver tuning with the low i-f stage. In almost every Motorola FM unit this stage is at 455 kHz. The low i-f coils are adjusted for maximum reading at the second limiter test point (make sure to keep the signal level low enough to prevent saturation). At this time also adjust the discriminator secondary for zero reading at the discriminator test point.

The next stage to be tuned is the high i-f stage. This stage may be first tuned by injecting a signal at the i-f and adjusting for maximum reading at the second limiter test point. These adjustments may be "touched up" when the carrier frequency is being received.

The rf stages can usually be adjusted by inserting a signal at the antenna jack at a

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fairly high level and adjusting the coils for maximum reading at either the second limiter or first limiter test point (taking care not to saturate the stage being measured). In cases where a signal cannot be forced through from the antenna jack, it is necessary to use an injection probe of some type and start at the final rf stage and work towards the antenna.

The carrier frequency may be adjusted by metering the discriminator test point and adjusting the crystal warp capacitor or coil until a zero reading is obtained.

The first step in tuning the transmitter is to put the high–low switch located near the final amplifier section in the low position. Or, if the unit does not have such a switch, disconnect the plate connections to the final amplifier tube. This is to protect the final from damage from prolonged periods of tuneup.

Actual tuning begins with the oscillator section and works toward the final. Each stage is tuned for maximum output. A metering point is usually provided at each stage. If the unit has been modified, especially if modified from 30–40 MHz to 6 meters, it will be necessary to check the output frequency from each multiplier stage. After every stage (except the final and driver) has been tuned, replace the final tube if it was removed. Tune the driver, final grid, and final plate circuits for maximum output. Next, go back through the unit and touch up the various stages.

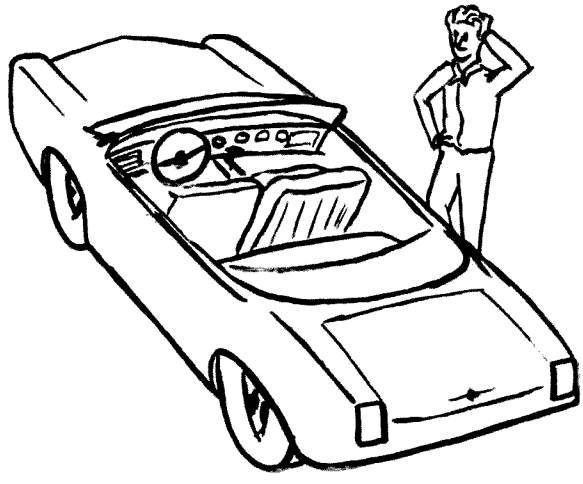
Antennas

The vast majority of FM operation is with vertically polarized antennas. These range from the simple quarter-wave whip to corner reflectors and yagis. The most popular mobile antenna for both 10 and 6 meter FM activity is the stainless steel whip with spring base. Next in popularity are the shortened antennas made by Antenna Specialists Company and others. The latter type may be mounted in the center of the roof or on the rear deck for better isotropic radiation.

Three types of antennas enjoy popularity with FM amateurs operating on 2 meters. They are the quarter-wave whip, the coaxial antenna, and the 5/8-wave, 3 dB gain antenna manufactured by Antenna Specialists and others. The quarter-wave whip can usually be purchased for under $5. The coaxial antenna can be purchased for around $20. The 3 dB gain antennas cost about $25, but they will effectively double the output power.

Base station antennas are also vertically polarized, and come in various sizes and shapes. The antenna generally in use on 10 and 6 meters is the groundplane, with the coaxial collinear antenna running a distant second. Both these antennas may be either purchased or constructed by the amateur.

In general, the following can be stated about VHF FM antennas: In mobile installations the best place for the antenna is the center of the roof. The next place is the rear



In mobile installations the best place for the antenna is the center of the roof.

deck or trunk lid; next comes the fender, and finally a bumper mount. In base stations, the rule is the higher the better while keeping line losses down. Remember that even the best coax has a great deal of loss at 2 meters and higher. If possible, use a very good grade of foam coax. Of course there are lines available with extremely low losses, but these are quite expensive and extremely hard to work with.

Glossary

Whenever an amateur first starts out he must learn the jargon used on the bands. The same is true when starting out on VHF FM. As an aid, twenty of the more common terms and their usual meanings are listed below.

Channel Guard: A registered trademark of General Electric for a system of *continuous tone squelch.*

Coffin units: FM units manufactured in the late 1940s and early 1950s such as the Motorola 30D which consisted of separate receiver and transmitter units housed in cabinets with rounded tops which resembled coffins.

Control heads: The small box-like unit containing the off-on-volume control, squelch control, and microphone connections of a trunk-mounted mobile unit. The control head connects to the unit via a multiconductor cable.

Continuous tone squelch (CTS): A system wherein a low, subaudible tone is transmitted continuously with the voice transmission. This tone activates a reed in the receiver which, in turn, allows the squelch to operate. If the tone is not present, the receiver remains muted. This system allows only the desired stations (those with the correct tone frequency) to be received. Provision is normally made to use either conventional squelch or an unsquelched monitor position.

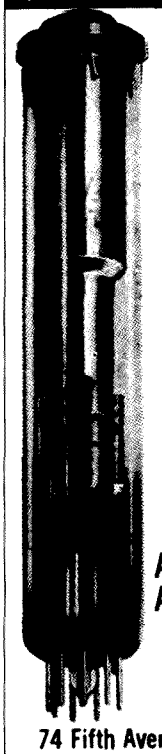
Deviation: The amount the modulated carrier varies from the center frequency. During half of the modulating cycle the deviation is positive and during the other half the deviation is negative. Commercial standards now call for ±5 kHz (narrowband). Most amateur operation is ±15 kHz (wideband).

Discriminators: The discriminator serves to convert the FM signal to AM and then demodulate the AM signal into audio. It is analogous to the diode detector in AM gear and the product detector in SSB gear.

High band: The slang term applied to the commercial band from 148 to 172 MHz.

IDC (Instantaneous Deviation Control): Motorola tradename for the potentiometer which acts as an "audio gain" which in turn controls the level of peak deviation.

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Limiter: A circuit i-f which saturates with a fairly low incoming signal, keeping the audio output from the discriminator at a constant level (similar to AVC in an AM unit). This circuit is needed because the audio output from a discriminator is directly proportional to the signal input, thereby varying with any change in signal level.

Low Band: The commercial band from 30 to 50 MHz.

Motrac: A registered trademark of Motorola for its series of mobile equipment utilizing transistorized receivers and hybrid transmitters.

Permakay: A Motorola trademark for its line of selective i-f filters. These are of two types, wideband (marked with a type number ending with the letter "W") and narrowband (marked with a type number ending with the letter "S").

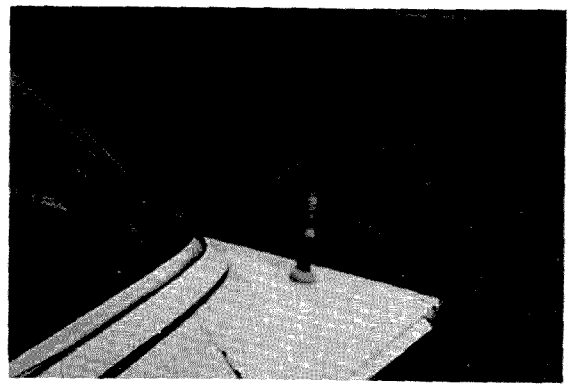
Pre-Prog: Slang term usually applied to General Electric units manufactured before the "Progress Line." Often this term is used to apply to units immediately preceding the Progress Line which are similar in appearance.

Private Line: The registered trademark for Motorola's version of CTS.

Single tone: The use of a high-pitched tone for control of remotely situated functions. This differs from CTS in that the tone lasts for only a short period of time. These circuits are often used in amateur repeater applications to restrict unauthorized use of the repeater and to reduce intermodulation effects.

Progress Line: A General Electric trademark for its pretransistor line of units. These units normally have vibrator power supplies. Newer types, with transistorized power supplies, are called "TPL."

TPL (Transistorized Progress Line): A trademark of General Electric used for their line of equipment utilizing transistorized receivers and tube type transmitters. The rear mount versions of this unit have the majority of the receiving circuitry located in the control head.



Twin V: A registered trademark of Motorola originally applied to mobile units capable of operation from 6 or 12V sources.

Warp: The pulling of the operating frequency by either inductance or capacitance changes being introduced in the oscillator or i-f circuit. This technique is also called "rubbering."

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As you look over the ads and articles in this issue of 73, you will see how the surplus field has changed. The amateur's legacy is still the obsolete AN/GRCs and such of the government. But it also includes the myriads of integrated circuit and semiconductor assemblies and components that have been replaced by the computer industry's bid for smaller, more reliable counterparts.

Contributing also to the surplus market was a decision by the FCC to make certain restrictions to commercial two-way radio users that would disallow use of all the older, tried-and-true radio transmitter–receiver units. As established radio users reluctantly parted company with their old wideband mobile units and base stations, the surplus outlets began to bulge with bargains. Since the amateur bands were not affected by the FCC ruling, the hams made excellent targets for the still-quite-usable gear.

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AN/URM-32	AN/ARM-26	AN/ARM-8
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AN/ARM-9	AN/UPM-98	AN/ARM-29
AN/USM-16	AN/ARM-68	AN/APM-66
AN/URM-44	OS-8E/U	AN/UPM-99
TS-757	TS-723	AN/USM-44
TS-684	TS-683	AN/UPM-32
TV-7	TV-2	TS-330
SG-24/TRM	ME-30C	TS-710
AN/PSM-4	AN/PSM-6	TS-621
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COLLINS 75A4 Excellent shape $390.00; Collins 32S1 with power supply, used very little $425.00. Walt Williams, 1706 Parkridge, Arlington TX (817-261-9653).

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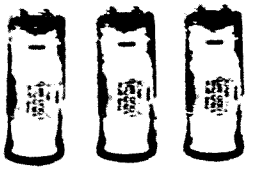
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WANTED: COLLINS 310B Does someone, anyone, have a 310B that I can borrow or buy? Jock White ZL2GX, 152 Lytton Road, Gisborne, New Zealand.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class License. plus-"Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: **SCIENCE FOR THE BLIND,** 221 Rock Hill Road, Bala Cynwyd, PA 19004.

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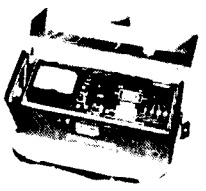
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Hugh Vandegrift DL4VA/WA4WME

Christian Ham Fellowship

The Christian Ham Fellowship is one of the newest of the many ham organizations among licensed hams in the country today. This new organization now has over 300 members and an explanation of the organization for those hams who might be interested is therefore given in this letter.

The purpose of the organization is to promote Christian fellowship among those hams who are Christians. To a born again Christian this is a vital need and privilege. A Christian Ham Callbook has been published and is available for a mere dollar donation to cover mailing and printing.

The organization also is active in gospel tract mailings, and many of the members have a gospel verse or two on their QSL card as their testimony. Anyone wishing to join the organization and simply believes that Jesus Christ is Lord and Savior is welcome to write in for a free data card on the organization. This data card is then filled out and their name is listed in the new issue of the Christian Ham Callbook. The main reasons for the organization's existence is to offer Christian fellowship among Christian hams and to learn how a Christian ham can be a witness for Christ to other hams.

Rus Sakkers W8DED
Box 218
Holland MI

QRP

With great pleasure, we wish to report the results to date of a number of QRP experiments, conducted by W7BVV, Bill Gibson, Salem, Oregon, and myself. Path length was computed to be 1650 miles, and frequency of operation is 28.760 MHz.

Date	Power	Mode	Station wrkd/hrd
12/29/69	2.5 μW	CW	W7BVV
01/04/70	2.5 μW	CW	W7BVV
01/04/70	25.0 μW	AM	W7BVV
01/05/70	2.5 μW	CW	W7BVV
01/05/70	25.0 μW	CW	W7BVV

Our computations and measurements imply that the minimum power required to maintain a CW circuit over the path between W7BVV and this station is on the order of 1μW. We continue to work towards this goal. We have worked many other stations throughout the US and Canada with power outputs down to 100μW AM phone. In addition, we wish to report that we worked CE7DW, Puerto Mont, Chile, 600 miles south of Santiago, with 250 mW AM phone, and received a report of 5 x 7.

Dick Shoup KL7YU
Box 5-828
College AK

Special FM Repeater Issue

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AMATEUR RADIO

73



73 MAGAZINE

#115 April, 1970

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A special featurette.

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Getting on frequency and other fine points.

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It's not dirty.

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The Cover

The cover this month shows what may well be one of the nation's highest repeater sites. Atop 10,700 ft Sandia Crest in New Mexico, the Sandia Crest repeater, WA5JDZ, provides coverage from Santa Fe to Socorro and interlinks with two other repeaters, WA5DMQ and WA5KUI.

Amateur Radio News Page

FCC ASKS FOR LICENSE FEE INCREASE

An increase in fees for licenses, applications and other services, totaling $20 million has been proposed by the Federal Communications Commission. In a notice of proposed rulemaking (Docket 18802) the Commission asked for comments on a fee schedule that would raise approximately $24.5 million dollars – the amount of the Commission's 1971 budget request. (Under present schedules, fees bring in about $4.5 million.)

In making its proposals, the Commission said that the Bureau of the Budget had urged higher fees schedules and pointed out, in addition, that the House Appropriations Subcommittee had stated that fees should be adjusted to assure that FCC activities would be "more nearly self-sustaining." The Committee had asked for a report on action in this respect by the time of 1971 budget hearings.

Fee increases are proposed for the amateur service, for broadcasting, common carrier, and other safety and special radio services. CATV and equipment testing and approval areas which presently are not subject to fees, are included in the proposed schedule.

Fees in the broadcast services would be substantially higher and would be based on market location, type of application filing service, hours of operation,

Foreign experience counts as Extra Class credit

Requirements for holding amateur Extra license have been broadened to recognize the operating experience required under a foreign amateur license, in an amendment to the rules adopted by the Commission, effective March 23, 1970.

The Commission action, amending Sections 97.51(a) and 97.9(a)(1) of the rules, makes an amateur Extra class licensee who was first licensed at least 25 years earlier by a foreign government, eligible for a two-letter call sign (a call sign having two letters following the numeral, such as W1AA), and gives an Extra applicant credit for foreign operating experience toward the two-year waiting period for the license.

Present rules provide for issuance of a two-letter call sign to an Extra licensee first licensed by the Commission at least 25 years prior to the date of his application, but do not recognize a license issued by a foreign government for the same period of time. Existing rules require that an applicant for the Extra license must have held a Commission-issued amateur license of other than Novice or Technician for at least two years, and do not now give credit for prior holding of a license issued by a foreign government. The Commission stated that the purpose of the present two-year rule is to help assure that Extra applicants have acquired practical operating experience for a reasonable time at a Conditional class level or above, but that one effect of the rule has been to deny recognition of operating experience acquired under amateur licenses from other countries.

Three parties submitted opposing comments stating that there are not enough two-letter call signs available to satisfy all the amateurs who may request them, and that the examination standards of foreign countries are lower than those of the United States. The Commission rejected both contentions, finding the number of two-letter call signs available more than adequate, and determining that the amateur standards of foreign governments are not relevant, since the licensee in each case must pass a Commission-administered amateur examination.

SAROC DRAWS RECORD CROWD

by K6MVH

Several thousand amateurs surprised Las Vegas townspeople (who have learned to accept the unusual) by showing up *en masse* for the annual SAROC funfest and third annual FM convention. The turnout this year exceeded that of all previous meetings in spite of the fact that it was held in a new hotel (the Stardust instead of the conventional Sahara), and a record number of rooms were occupied by convention attendees.

Highlighting the convention were daily "cocktail parties" sponsored by Ham Radio, Galaxy, and Swan. It was fun to relax and watch all the old conservatives let their hair down and sing along with Leo Meyerson, who kept the liquid and the music flowing.

The FM portion of the convention was a bit of a letdown in that fewer repeater people attended than in previous years. The fun was marred even further by a couple of hard cases who got out of hand and gave the hotel management a hard time by playing radio with their handie-talkies a little too near the hard-and-fast action of the casinos.

The one element that tended to make the whole affair worthwhile was the "hospitality" suites, one for the FM'ers

and authorized power. In addition to increases in current fees, new fees are proposed for grants of construction permits, assignments and transfers, pay-TV authorizations and various other types of applications. Ham fees would be more than double the present rate, the FCC said.

Because of the high number of licenses in the Safety and Special Radio Service, the Commission said it was impracticable to establish separate filing and license fees. Increases are proposed, however, in single fees. Safety, local government, emergency, and closed-circuit educational TV are among services that are not now required to pay fees and which will continue to be exempt. But ham license fees would be hiked to more than double the present rate, the Commission said.

The Commission first adopted a schedule of application fees in 1963 with the initial fee schedule taking effect on March 14, 1964. The action was upheld in a court test in 1964.

Comments on the rulemaking are due on or before *April 20, 1970*, with reply comments due May 11, 1970.

DX'ERS CONGREGATE IN FRESNO

by A. F. Iverson WA6ZCQ

The big guns from W6-land met in conclave during the weekend of February 1 at the Del Webb Towne House in Fresno, took a good hard look at those they have been in mortal combat with during the preceding year, and decided that they weren't such bad fellows after all. All in all it was a tremendous turnout; 225 people showed up and most took rooms at the hotel. It was a cold, dry and foggy day in Fresno, but with all the activities on the program and especially the "happy hour" just before the dinner drove out all thoughts except having a good time. The talks, the slides, and the fine comradeship expressed between each other – coupled with an exceptionally good dinner – made the whole thing a big success.

Congratulations to the officers of the Northern and Southern California DX clubs, and especially Frank Cuevas W6AOA, who spent many hours putting the program together and securing Bill Rohrer W7ZFY (Heard Island) as the main guest speaker.

As a footnote we would like to see other ham groups have get-togethers such as this to improve their personal relationship and then to read about it in the various publications around the country.

VHF FM/AM HAMS ASSIST IN OKLAHOMA INOCULATION PROGRAM

by WA5JGU

Bob Cunningham, the Oklahoma City Civil Defense Radio Officer, requested amateur assistance for the Rubella inoculation drive Sunday, February 1.

20 to 25 clinics were set up in Oklahoma County. Mobiles, 6 meter AM and 2 meter FM stations were set up at clinics to coordinate activities. The VHF club and the FM repeater group covered the entire county.

WA5HWN and K5SKA were net control on 50.50 MHz. W5GGB, the Explorer Scout Post 5 station, served as net control for FM activity on 146.94, and another for MARS enthusiasts. Thanks to Tom K7TDQ, Squeak K7RBM, and a few other local FM ops, the FM suite was kept open on an almost continuous basis, and it was kept fully stocked with all the condiments one comes to expect from such places.

A considerable amount of praise is due Leonard Normad for the tremendous amount of work he puts out each year to make SAROC a success. And all indications are that he is already hard at work planning the next big shindig, nearly a full year away.

QSL Cards for Belgian Stations

The UBA asks all IARU member societies that QSL cards for Belgium be sent to the only official QSL bureau: UBA, QSL Bureau, Post Box 634, Brussels 1. The UBA has asked the editor of the US Callbook that this address be reinstated immediately in future editions. Its omission follows the action of a small private group of Belgian amateurs. UBA asks that all member societies of the IARU publish in their journals the correct address of the UBA QSL bureau.

From "IARU Region 1 News":

Ham radio in Roumania

In Roumania, amateur radio is apparently under the control of the national countil for physical education and sport, an organization supported by the government. There is a council of some 40 members, mainly from around the Bucharest area but the administration is mainly conducted by an executive bureau of eleven persons. The president is also the minister responsible for pots and telecommunications.

A paid general secretary YO3JP, together with a secretariat, is responsible for a central office. Roumania is split up into 40 administrative countries, and each country has a paid administrator who is the secretary of the radio club in that area.

Three classes of license exist in Roumania. The Novice class permits operation on the 3.5 and 7 MHz bands, with a maximum licensed power of 25 watts, and on the 28 MHz band with a maximum licensed power of 5 watts. Normal class licensees are allowed to use 100 watts on the 3.5–28 MHz bands with all normal modes of emission and 25 watts on 2 meters and other VHF bands.

With the submission of information on the results obtained, it is possible to obtain an Advanced Class license, which permits the use of 400 watts input power. Some 35 operators apparently have these facilities. The address of the Central Radio Club is Box 1395, Bucharest 5, Roumania.

Reciprocal Proliferations:
WA2's short-call try backfires...

DXers have been startled recently by the appearance of some new and strange call letters on the bands. This is going to do nothing but get worse. Reciprocation has hit the Caribbean heavily and it is now possible to obtain an operating permit in virtually every one of the islands if you have along your FCC license and proof of citizenship.

Sam Laine W2BKU arrived in Antigua shortly after the new regulations went into effect and applied for a license. Since he was the first one to get the new type of license they offered him VP2AA1. Sam threw up his hands in horror ... imagine trying to get an unusual call sign like that through the QRM! Okay, says the Communications Director, if you don't like that we can use your initials. That sounded better and the license was duly issued. When Sam opened it he found that he had VP2AASL. He is not at all sure that this is an improvement over VP2AA1.

The same day Bill Williams WA2GQT applied for a license on Antigua and received VP2AAMW, another mouthful.

The French have decided to permit reciprocation in their "departments." This means that the old rule that we could get a license to operate in France, but not in other French possessions has been changed and now the way is clear for us to hit all those juicy and little used areas such as FL8, FO8, FK8, FP8, FM7, FG7, FS7, and even FY7.

ARRL Handbook

The 1970 edition of the ARRL's "Radio Amateur's Handbook" represents a definite step forward for the League, which has been having trouble in the past keeping the book apace with the rapidly expanding and ever-changing technologies that move and advance the hobby of ham radio. Numerous updated construction projects are included, among which are power supplies from 3V to 3 kV, solid-state receivers and transmitters, plus several new VHF and UHF converters. Two new linears are described in the transmitting chapter, and the UHF/VHF chapters have been blessed with a variety of new projects.

For the first time in the history of the Handbook, a complete chapter has been devoted to VHF FM. Though just a smidgen more than three pages are devoted to this phase of the hobby, the amateur FM activity in the U.S. is surprisingly well covered. Since the material was prepared by a knowledgeable FM'er (W6GDO), I suspect that the two or three technical errors in the FM section were edited in by Doug DeMaw, the league principal responsible for publication of the Handbook. This edition contains 710 pages, including catalog section and index. There are over 1300 illustrations, many of which have been revised, and an inordinately large number of tube-base diagrams. Price is $4.50 in the United States and Possessions, $5.00 in Canada, and $6.00 elsewhere. As always, it is also available in a hard-covered clothbound edition.

Licensee "Hamworthiness" Questioned by FCC

Applications by John A. Abernethy, licensee of Amateur radio station K4OKA, Hickory, North Carolina, for renewal of General class amateur radio license and for an Advanced amateur radio license have been set for hearing by the Commission.

The Commission said there was a

BIRMINGHAMFEST
by W4FKG

The Birminghamfest this year will be on May 3 at the Armory on Oporto Avenue (just off U.S. 78 East - near Eastwood Mall). For entertainment, prizes, contests, net meetings, eyeball QSOs and fun for the entire family, plan to attend. For further information contact the Birmingham Amateur Radio Club - W4CUE Box 603, Birmingham AL 35201.

WABASH COUNTY FEST

Wabash County Amateur Radio Club's second annual Hamfest will be Sunday, May 24, 1970. Rain or Shine. Held at the Wabash County 4-H Fairgrounds. Activities will include door prizes, Bingo for the XYLs, fleamarket, technical session on the Fort Wayne VHF repeater. Tickets $1.00 at the door. For further information write Bob Mitting, 700 Centennial St., Wabash, Indiana 46992.

Long Island club makes plans for FM reoeater

A group of FM enthusiasts within the Long Island Mobile Amateur Club organized a meeting of a steering committee which would plan and implement a repeater system designed to enhance L.I. mobile and emergency communication. The meeting was held at the home of Ed Piller W2KPQ on 15 January 1970 to discuss the existing repeater situation and to generate plans for a Long Island Mobile Integrated Communication System (LIMICS).

Harry Dannals W2TUK, ARRL director (Hudson Division) appeared as an observer; also present were Fred Brunjes K2DGI, Section communication manager ARRL NYC-LI section; Jim Fahnestock W2NM, member Suffolk County Radio Club (SCRC); Art Raunch W2DID, treasurer SCRC; Van Field W2OQI, radio officer for Civil Defense and emergency coordinator of Suffolk County and member SCRC; Gerry Harrison W2ZGA, member LIMARC FM committee and SCRC; Ed Pores WA2ZBV, vice president LIMARC and member SCRC; Jules Rivman W2TD, vice president of Hudson Amateur Radio Council and member LIMARC FM committee and SCRC; and Ed Piller W2KPQ, LIMARC director, chairman LIMARC FM committee, and member SCRC.

As 146.34 and 146.76 MHz are being adopted more and more nationally as service area. Contact will be made with other surrounding repeater groups using these frequencies so as to minimize cochannel interference problems. Technical standards are to be as outlined below:

Input frequency:	146.34 MHz
Output frequency:	146.76 MHz
Output power:	10W minimum
Deviation:	15 KHz (narrowband)
Tone coding:	Initially open; may be tone-coded later
Control point:	Minimum of two and as designated
Operating Hours:	Continuous
Site location:	To be designated
Transmission cutout:	After predetermined interval
Logging:	Automatic logging

FOURTH ARIZONA QSO PARTY

The fourth Arizona QSO Party is sponsored by the Saguaro High School Amateur Radio Society. The contest begins at 2100 GMT Saturday, April 25, 1970, and ends at 2100 GMT Sunday, April 26, 1970. All bands and modes may be used. Stations may be worked twice per band, once on CW and once on phone. Arizona stations send contest number, RS(T), and county. All others send number, RS(T), and ARRL section or county. The call will be CQ Arizona or CQ Test de (call) Ariz K. Arizona

News, Reviews, Announcements

. . .Way Down in Columbus, Georgia:

The annual Columbus, Georgia hamfest will be held April 5 at the Fine Arts Building behind the Municipal Auditorium at the fairgrounds. For information, write John Laney K4BAI, 1905 Iris Drive, Columbus, Georgia 31906.

HAM HOSPITALITY

NEW YORK - Dana Polan WA2JLV offers overnight accommodations to Stateside and foreign DXers. Write to: RFD Box 44A, Putnam Valley NY 10579 or call: 914-528-3759. Richard H. Eckhouse, Jr. WA2CVL also offers overnight accommodations: 87 Lincoln Road, Amherst NY 14226.

NEW HAMPSHIRE - Jean Pierre Catala F2BO/W1 welcomes one or two U.S. or DX hams for overnight stays. Accommodations are modest (couch), but languages are no barrier if you speak English, German, or French. Address: H1 Forest Park, Durham NH 03824 or call: 603-868-2847.

ATTENTION HAMS WHO VISIT OR TAKE IN VISITORS:
How are you making out with Ham Hospitality? Tell 73 about your visits with fellow amateurs – what you did, what you saw, whom you met, the language barriers, the fun . . .Write to Hospitality Editor, 73 Magazine, Peterborough NH 03458.

Georgia QSO Party

Starts: 2000 GMT, Sat., May 9, 1970
Ends: 0200 GMT, Mon., May 11, 1970

substantial question as to the applicant's qualifications to hold an amateur operator and station license due to the nature of communications he has allegedly transmitted over his station in the past.

The issues to be determined at the hearing include: the facts concerning communications transmitted over K4OKA by Abernethy on or about November 13, 1965; January 11, April 27, October 30, November 4, 1967; January 14, 1968; October 28 and 29 and December 14 and 26, 1969; and January 1, 1970; whether the communications transmitted on those dates were consistent with the basis and purpose of the amateur radio service as outlined in section 97.1 of the rules; whether the communications were contrary to the terms and conditions specified on the applicant's license and otherwise contrary to the public interest, convenience, and necessity; whether Abernethy transmitted unidentified signals and willfully or maliciously interfered with radio communications, in violation of section 97.123 and 97.125 of the rules; and whether Abernethy possesses the requisite qualifications to be a licensee of the Commission.

From "The RaRa Rag":

Two Meter FM Group Organized

The Rochester repeater group has received the club call WA2UWQ, which will be used for a repeater. Charlie Mills K2LDU is trustee. Initially, it is planned to install a repeater at Charlie's home; later, that repeater may be installed at a remote site.

John Plumeri W2KZD is heading up a group that is hard at work installing a repeater at a Pinnacle Hill site. When both repeaters go into operation, it will put Rochester into the FM "major leagues" with two repeaters.

The repeater at Charlie's home will be set to operate on 146.28 MHz in and 146.88 MHz out. The unit on Pinnacle Hill will operate on 146.34 MHz in and 146.94 MHz out. When both are in operation, it will give Rochester local and national repeater coverage.

open input and output repeater frequencies, it was decided that it would be desirable to occupy these frequencies for repeater coverage of Long Island. W2OQI indicated that he could also use the 146.76 MHz output frequency in conjunction with his repeater at Manorville, N.Y. in the future.

Tone Coding vs Open Repeaters

Discussion of tone coding resulted in a decision to use open repeaters so that visitors from out of town could operate them. On the other hand, as chaotic conditions could arise with open repeaters in a high-population area, some simple type tone coding or whistle-on technique may be desired. This is still an open question and final resolution was shelved pending further study.

Repeater Standards

A narrowband system will be employed and the effective radiated power will be as low as possible consistent with adequate service within the designated

Somerville To Issue Special Award

by K1YUB

The Somerville Mass. Amateur Radio Club (WA1MHN) will be operating from the summit of Mt. Washington, the highest point in the northeast, on the weekend of May 23–24, 1970. Operation will be on both days from 1800–2000 GMT on the following schedule:

Band	Mode	Freq.
15	SSB	21.375
10	SSB	28.650
6	AM	50.274
2	AM	145.470
UHF	FM	449.050

Any station establishing two-way contact with WA1MHN on two different bands will be eligible for a special certificate upon receipt of a request for it and 25¢ to cover printing and mailing. Address inquiries to Civil Defense Department, Somerville MA 02145.

stations score 2 points per QSO multiplied by the number of ARRL sections worked. All others score 5 points per QSO multiplied by the number of Arizona counties worked (maximum of 14). Suggested frequencies: (CW) 3575 7075 14075 21075 28075, (phone) 3950 7275 14285 21375 28600, (novice) 3735 7175 2110. Certificates will be awarded to the top scorer in each section. When 4 or more logs are received from one section, a second place certificate will be awarded. Logs must show date and time in GMT, stations worked, bands, modes, and information exchanged. Please enclose an s.a.s.e. with your logs if you wish to receive a copy of the results. Send logs to Bob Wright, WA7ISP, 4725 N. 70th Street, Scottsdale AZ 85251 before May 25, 1970. All stations must submit a statement that all regulations have been followed and that decisions of the contest committee will be accepted as final.

Alaska okays Amateur call plates

For a mobile amateur radio station for which special registration plates are issued, the applicant, in any recognition of his service to the public, shall not pay any additional charge for special registration plates, provided he annually files his registration before November 1; in addition to the requirements of sec. 50 (a) (5) of this chapter, the station must be satisfactorily proved capable of being utilized 24 hours a day, must have a transceiver capable of operating on 75 through 10 meters, must have an antenna, and must have a power supply and wiring as a permanent part of the vehicle; the transmitting unit may be removed from the car for service or dry storage; the annual license tax is $1 for (other authorized) mobile amateur radio station vehicles, provided the annual registration is filed before November 1.

The ninth annual Georgia QSO Party is sponsored by the Columbus Amateur Radio Club, Inc. (W4CVY).

There are no time or power restrictions and contacts may be made once on phone and once on CW on each band with each station.

Exchange: QSO number, RS/RST report and QTH: County for Georgia stations; State, Province, or Country for others. (Georgia to Georgia contacts permitted.)

Scoring: Each complete contact counts 2 points. Georgia stations multiply their total QSO points by number of different states and Canadian provinces worked. DX stations may be worked for QSO points, but do not count as multipliers. Out-of-state stations will use the number of Georgia counties for their multiplier (a possible total of 159).

Awards: Certificates to the highest scoring station in each state, province, country, and Georgia county. Second and third place awards will be made in sections where additional recognition is deemed to be warranted. A plaque will be presented to the Georgia station submitting the highest overall score. Plaques will also be awarded to the highest scoring out-of-state entry, to the Georgia club with the highest aggregate score, and the highest scoring portable or mobile entry from a station operating outside his home county.

Suggested frequencies: CW: 1810, 3590, 7060, 14060, 21060, 28060. SSB: 3975, 7260, 14290, 21410, 28600. Novices: 3725, 7175, 2110.

Your log should show: date and time of contact in GMT, station worked, exchange sent and received, band used, type emission, and multipliers claimed.

Include a signed declaration that all contest rules and operating regulations have been observed and mail your entry to Columbus Amateur Radio Club, Inc., Attention of John T. Laney III K4BAI, 1905 Iris Drive, Columbus GA 31906. A large self-addressed stamped envelope will be appreciated.

Entry should be postmarked no later than June 8, 1970.

HAM FEE HIKES PLANNED BY FCC

by Ken Sessions K6MVH

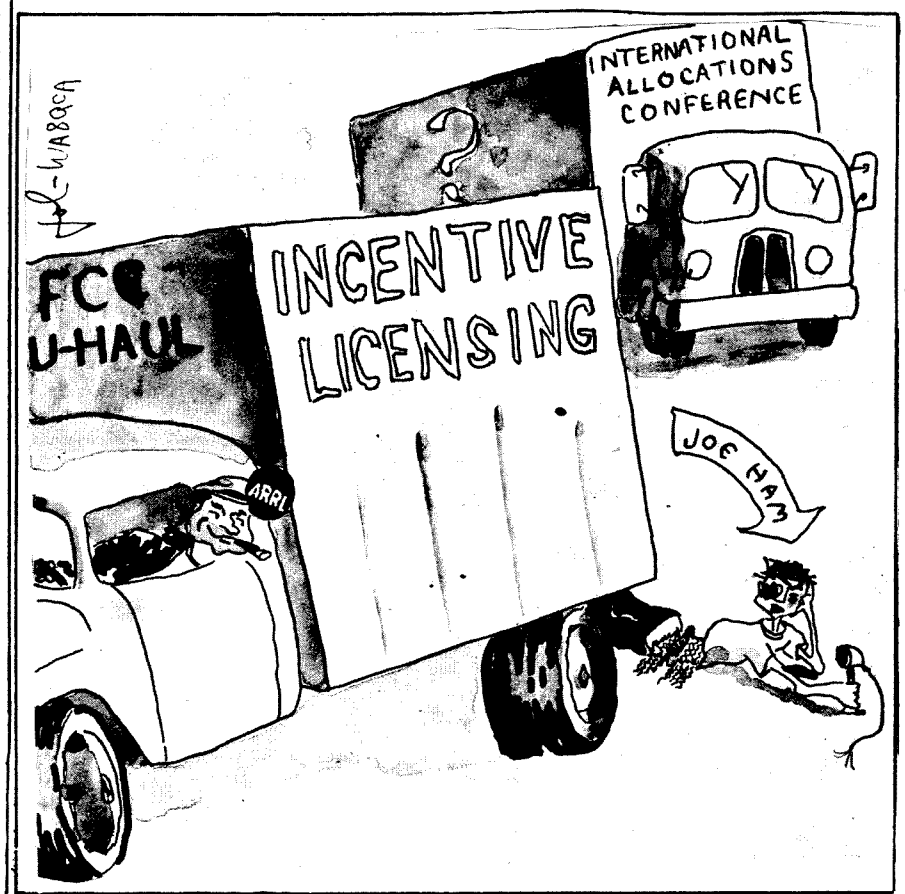
The FCC is holding up a glistening shaft on which it hopes to impale virtually all of the radio services. In response to a suggestion from top government officials, the Commission seeks now to increase the fees of license applicants as an attempt to balance a projected 1971 budget. Hardest hit by the move will be the broadcasters, whose lobby will doubtless resist the action with all the force it can muster. But the amateur service, with no protecting arm in Washington, will be at the mercy of the federal fund-raisers.

If the FCC has its way – which is usually the case – each amateur who wants to renew his station license will have to pay a fee of $9 – more than twice the amount now imposed. Clubs and individuals who want to apply for a special callsign will be required to pay $25 (rather than the $20 fee now levied).

The Commission's quiet announcement about the proposal (Docket 18802) said that comments were invited with regard to the planned rulemaking actions; but the kicker was that such comments were required on or before April 20 – which left nowhere near the amount of time needed to spread the word to amateurs who might want to protest the docket.

Wayne Green, publisher of 73, submitted a formal petition to the FCC requesting that the deadline for comments be extended for an additional 60 days. This request, he said, would give the major amateur journals enough time to publish pertinent facts and gather comments from interested amateurs. Green submitted his counter-petition on the same day the FCC served notification of the proposed rulemaking. No word has come from the FCC yet as to whether or not Green's postponement request was accepted.

Amateurs everywhere should make their individual voices known to the Commission. An amateur lobby would tackle this problem for us, but we are not blessed with Washington representation. It thus becomes necessary for *individuals* to protest the actions proposed on Docket 18802. Write today to the FCC, Washington, D.C. 20554. Don't plan on getting the extension. Make sure your comments are in the hands of the FCC well before the April 20 deadline. And get the word to members of your club just as fast as you can. This is an important issue, and we'll have no time to spare.



Editorials

Teletype Relay Outputs on FM Repeater Freq.

The Los Angeles area is being "served" by the WA6ITC radio repeater Teletype station. The repeater operates with an input frequency of 146.58 MHz and regenerates Teletype tones on the Los Angeles FM repeater frequency of 146.70 MHz.

According to Martin Geisler, licensee of the RTTY repeater, the transmitting and receiving equipment is situated atop the Santa Monica Mountains at an altitude of 2400 ft. As most of the local FM repeater users will sadly attest, the RTTY repeater has excellent coverage over the Los Angeles basin. Geisler says good signal reports have been received from as far south as San Diego and he has high hopes for extending the range north into Santa Barbara.

As many as 15 stations have used the RTTY repeater as a fully automatic message system. Geisler says he wants to encourage more users. Though not popular with the 100-odd people who use the W6FNO FM repeater, which shares the same output frequency, Geisler expects his system "will become popular with message handlers accepting trunk traffic from the low bands" who will find it useful for trunking the traffic locally. Since the RTTY equipment is crystal controlled, automatic operation is effected without the presence of an operator at the receiving end.

Conflict

The real story of the WA6TIC RTTY repeater is a great deal more complex and detailed than might at first seem. The output frequency was established on 146.70, which was already in use by the

With respect to the additional assessment for license fees, 73 feels that the contributions of amateur radio to society more than offset the cost of license processing. The electronics technologists in this country, for example, in large part are taken from the ranks of amateurs or former amateurs. And the communications capability of amateurs, so exploited during the war when operators were drafted *en masse*, has always added significantly to the "peace of mind" of the government. This is reinforced by the continously improving organization of amateur groups who provide an instant-readiness to serve local governments at the first hint of a need.

It seems incongruous that the amateur radio service should fall prey to the FCC's revenue drive – particularly in view of the fact that amateur radio falls within the official category of "Public Safety and Special Services," set up for the benefit and convenience of the nation.

What has ham radio meant to the United States? Well, try these for openers:

1. Every ham is a goodwill ambassador to the otherwise unreachable citizenry of foreign countries.
2. Amateur radio provides the ideal medium for getting young people interested in pursuing the vital field of electronics and related technologies.
3. Amateur operators provide the only fully organized mobile communications force that is *always* ready to be used in any disaster or emergency situation.

The points mentioned above are so important to this nation that 73 feels a strong case could be made for requiring the government to actually subsidize ham radio – furnishing the gear and paying the operators. Not that we expect that or want it. But it is difficult to see how the FCC can justify added fee assessment when, by the FCC's own admission, the real worth of the hobby is its value to the country.

ITU CONFERENCE: Who lobbies for ham radio?

by Wayne Green W2NSD/1

If the amateur shortwave allocations are to survive the next ITU frequency allocation conference in a recognizable form we need to have some basic changes made in the instructions given to the delegates – U.S. and foreign.

This sorts itself out into two projects, getting the support of the U.S. delegation and getting the support of all of the foreign delegations. Neither of these is going to be easy.

The U.S. delegation can be worked on at many levels. It is made up of representatives of the many radio-using services, a good proportion of them government run. The basic approach to changing governmental thought is to work through the mechanism set up for this: congress. Congress has considerable influence since it watches over the governmental departments with committees and it hands out the yearly allowances.

Since the only legal way for any amateur organization to approach congress is by means of a representative who is registered with congress to lobby, we have a serious problem. A tax-free organization cannot lobby ... ARRL is tax-free ... thus, unless ARRL changes its tax-free status, no employee or representative of the League can risk even talking to a senator or representative. ARRL cannot change to a tax-paying basis without radical changes in its management, so it is extremely unlikely that this will take place.

One man with the time and money probably could make a profound change in the attitude of the U.S. delegation to the ITU. It would take time, to be sure, for he would have to sit and wait to see busy senators and representatives, see top brass military, FCC commissioners, and on down the line. The end result would be that the delegates sent to Geneva would be instructed by their superiors that amateur bands are to be kept intact, even if their particular service suffers a loss. In the past we have had large quantities of lip service paid to the amateurs, but when it got down to a loss of frequencies for any service, they looked to the nearest amateur band for replacement.

Foreign delegates can be reached through high government officials. Amateur radio is of critical importance to every country for it provides one of the best ways for them to interest youngsters in a technical education. No country can keep pace or development without large numbers of electronics and communications men. Without amateur radio, how can the thousands needed be interested in turning to this field?

One man could have a profound effect on this whole situation if he had the time to see government officials and make them aware of the importance of our hobby. This is needed mostly in Africa and Asia where new nations are trying to bridge the gap into the modern world of computers and satellites. These same countries hold the critical votes at the ITU.

The amount of money needed to apply pressure at home and abroad is minuscule to any large business or club ... probably a mere $50,000 a year could make the difference between our having a healthy and expanding hobby in the future instead of a gradually emasculated hobby. ARRL has the 50G to burn, but has not the will to use it. No one else has the 50G. What do we do now?

Los Angeles area FM 2 meter repeater. As a result, when radioteletype signals are fed into the WA6ITC machine, the local FM repeater, principally a mobile relay facility with more than 100 users, is virtually forced out of service.

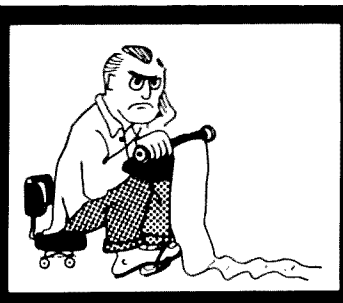
Even though 146.70 MHz was a "vacant" channel when the FM repeater was installed, the RTTY enthusiasts (5 in number) rallied to save the "national" RTTY channel from being usurped, and eventually had put up the RTTY repeater so the output would "capture" the local FM repeater. Perhaps the FM'ers were shortsighted in putting up the repeater on a channel recognized nationally as a radioteletype frequency. And perhaps the five RTTY men were rambunctious in their selection of an already-in-use channel for their base-to-base communications. Certainly, there are two sides to the issue. Since there is no compatibility between the two modes, the FM group has offered to put the controversy before the ARRL-affiliated Los Angeles Area Council of Amateur Radio Clubs for arbitration. If the RTTY repeater group agrees to allow the council to act as arbiter, the next few months could see a new repeater forming and a shift by either the RTTY stations or the FM crowd.

REPORTERS WANTED

Write for the 73 Amateur Radio News Page under your own byline! The News is looking for items of general interest ... hamfests coming, hamfests just happened, expeditions, emergencies, special events, anything of special interest that might have happened on any band, new records, moonbounce news, FM repeater openings, unusual club activities, whatever turns you on.

Reporters whose items are selected for publication will receive a special press card which may help them get into places closed to the general public, making the reporting of emergencies and special events a lot easier.

The deadline for all reports is the 15th of the month. Reports received earlier will get preference as there can only be room for a few last-minute items.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

How Fast Can You Work 100 Countries?

When I first put in my present station five years ago it took me a good two weeks to work 100 countries. By way of proving I'm not sure just what, I took advantage of the first weekend of the ARRL DX phone contest this year to see if I could make WTW–100 all in one weekend on 20 meters.

Feeling a bit overconfident, I started over an hour late...but, after all, it was the first night out for dinner since the baby arrived a month ago, so I didn't want to strain family relations by rushing too much. Wives have a hard enough time getting used to seeing just the back of your head on your weekend at home without starting things off badly.

South America and Africa came through fine for about three hours and then the band folded for the night. With the exception of 9N1RA and FR7ZC, none of the 33 countries contacted were particularly rare. Jinny has certainly been active from Nepal and her signal was outstanding.

When I got up the next morning the band was busy with Europeans. By afternoon I was up to 73 countries and had hopes of getting the hundred within 24 hours. Three hours later, with only three more countries added, it was obvious that this was going to take much longer than I expected. I had a leisurely dinner, watched some television, and helped mind the baby before going back to the band.

It was definitely hard going. I had worked just about everything in Europe except the hard ones such as HV, 9A, 3A, HBØ and the like. I tried not to make too many duplicate contacts, but every now and then a pileup would prove irresistible and I would plunge in for an extra VU2, CT2, UW9, or something reasonably rare. I went to bed with 87 worked and the band dead at midnight. Thirteen more shouldn't be all that hard the next day, right?

A 5:30 start netted me a few new ones, starting with my good friend Chet PJ2CC down at the Beachcomber Hotel in Curacao. By 9:00 a.m. I was up to 93, but the band was full of nothing but unrare Europeans, so I went back to bed. Pierre F2BO/W1, his wife and twin babies arrived at noon for a visit. I got back to the rig about 3 p.m. and, when the band finally opened to Africa again, worked my way up to 99. With two hours to go that shouldn't be a big problem. It was, and I snagged 6Y5AV out of a horrendous pileup with just seven minutes in the contest to go, making it 100 exactly.

My total operating time came to only 17 hours, so I had a great time without getting too tired. Some of the fellows who had been chasing DX on four or five bands, making 1500 to 2000 contacts, were pooped for fair. I made only 132 contacts. Three of the countries were new for me, but for the most part I was surprised at the lack of rare countries in the contest. Two of the three new ones were not really in the contest, but just happened to be around. The activity in Africa was extremely sparse, with less than ten stations giving the contest much effort. The band was open to Africa quite a bit, but all that I could hear were three CR6s, a couple of ELs, a couple of ZSs, and 5H3LV. North Africa didn't open up much at all, with 9H1CD complaining of sitting there hearing the Ws weakly for seven hours before he was able to make his first contact.

One thing was very obvious...the General class licensees didn't have a chance in the world of seriously getting into the contest. Only during rare high points of activity would the action spread on up to 14.275. A General might just as well forget working DX on 20 meters.

My station, for those picturing mammoth beams on top of a mountain, along with a room full of equipment, consists of a five-year-old transceiver, one of the least expensive made, a Henry linear amplifier (2K, not 4K), and a simple three-element beam up 70 ft in downtown Peterborough.

Leaky Lines vs Technicians

When the February LL column arrived I read it to a Tech and he turned livid. I knew we had a winner. Even the gentlest discussion of cheating on the Tech exams makes most Techs fighting mad, with those who cheated to get their ticket having an edge on the degree of ferocity.

The cheating that takes place is generally done in friendship, though it leaves both parties feeling guilty afterward. We had the same problem with the Conditional license and that had a

lot to do with the virtual elimination of that license class.

Cheating is a problem and it is not one that will go away if we refuse to discuss it and try and work out some reasonable solutions. It is extremely difficult to discuss because of the emotional factors. Those who were absolutely honest on their exam and code test are affronted at the suggestion that they might have been helped. Those who were helped are feeling guilty and would prefer that something else be talked about.

One solution that I have proposed in the past is a little change in the rules which would make it necessary for exams to be given by three licensed amateurs instead of one, figuring that it is a whole lot more difficult to get four people to agree to something dishonest than two.

Let's give some thought to the Tech license. The Tech license differs in two quite basic ways from the General: There is the difference in code speed, 5 wpm opposed to 13; and there is the manner of administration of the license exam, with the General having to face an FCC examiner – and the Tech, his friendly local licensed amateur.

In considering the matter of code speed, the philosophical arguments about the usefulness of code are irrelevant. The fact is that under the rules now existent you do have to learn to send and receive the Morse code at 13 wpm if you are going to get a General license.

How much of a barrier does the code present? How much of a difference between getting the General and the Tech licenses is due to the problems of learning code? Amateurs who have helped thousands to get their General license tell me that *anyone* can learn the code and pass the General exam. Some people take longer than others, of course, but apparently no one can honestly plead an inability to learn code. Once the decision is made that the code will be learned, the process takes amazingly little time, from mere days to, at worst, weeks.

On the face of it, the code would not seem to be enough of a problem to prevent anyone from getting the General license.

Which brings us to the FCC examiner. Now, I recognize that it is entirely possible to copy 15 wpm perfectly the night before the exam and still fail miserably just from the tension and panic of taking the FCC exam. I've not only seen it happen, I've experienced it myself. But eventually you do calm down enough to copy enough letters to get through the code test and you are ready for the technical exam.

The written part of the test should be about the same, whether you are with a friend or at the FCC emporium, unless you need help with the hard spots, in which case the FCC could be more difficult.

Code Requirement: Dirty Words?

Many a CB'er, SWL, and even Novice amateur has had good cause to curse the Morse code. I hope you will not turn off if I suggest that there may be a very good reason for keeping the code requirement for the amateur licenses.

Yes, I think I know all of the arguments against the code. It is an anachronism. It is a relic of the past. I agree with that, but I don't agree that that is all it is. Yes, I know that teletypewriter and radioteletype have made devastating inroads into the commercial use of code. I know that the military uses it very little any more.

One of the principal users of Morse code is the amateur, I suspect. Code is still alive in many of the ham bands–and not just the Novice bands, where the operators are limited by law to that mode of emission. There is a lot of ragchewing going on in the code-only portions of the bands, a lot of DXing, and a lot of traffic handling around the dozens and dozens of traffic nets organized by the ARRL. But even this is not a good reason in my mind for the insistence that all amateurs know the code. I figure that those who like it will develop their ability to use it, and those who don't can just go ahead and use phone. Whatever turns them on, I say.

The fellows who are using code tell me that it is fun, that they enjoy it enormously. If this is so, then I'm not sure that I can agree with those amateurs who feel that we must insist that every newcomer learn the code to get his license because if he can get a license without learning the code he will never try it. I suspect that communication by dots and dashes might just be a whole lot more popular if it weren't jammed down our throats. I am pretty sure that my own antipathy to code is a result of my having to learn it, whether I liked it or not. I resented that and reacted to it negatively. I enjoy things a lot more when I do them of my own free will.

There is a basic difference between having to pass the written technical exam and the code. I could see where the technical exam was important as an eliminating factor for those fellows who do not have enough knowledge to properly operate an amateur station. That made sense. But why code? I had no need of it if I was going to operate phone, so why force me to develop a skill, as opposed to a technical understanding? An unneeded skill, at that!

Some amateurs argue that in times of emergency code might be the only mode that could get through. Balderdash! Forty years ago, maybe. But today most of the emergency rigs are mobile phone rigs, usually sideband. And I have yet to see many cases where sideband can't get through just about as well as code. That is a very weak argument to me.

So what possible reason is there left for the excruciating and frustrating process of code-learning being part of the amateur license? And not just a part of it, but by far the most difficult part to master. The technical end is considered by most amateurs as being terribly simple. Virtually any EE college graduate can walk into an FCC office and pass the amateur General

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exam with just a few hours' study of the rules. Why, when amateur radio is supposed to be a technical hobby, is it in reality a skill hobby instead? The technical end seems to fade into insignificance compared to the skill aspect.

The answer should be getting obvious now. Anything easily obtained is not treasured or appreciated. I suspect that the very difficulty of the code requirement is one of the basic reasons for the legendary ham spirit . . . the pride of being a ham. It is most definitely an accomplishment to pass this hurdle, particularly in this day when virtually no one else is using the code. This means that the code has to be learned specially for the ham ticket by *everyone*.

Show me one person, if you can, who is not proud of his ability to copy code. Sure, I know thousands of hams who haven't been using code for years, but I don't know one who doesn't swell a bit with pride when talking with nonhams over his having passed the code exam.

RM-1456

It seemed to me that one of the problems facing the Techs is their isolation from CW and that if they had more of an opportunity to use it they might be inclined to go for their General. The code, as I said before, is not difficult to learn once you make up your mind to have at it. In spite of the nice special CW band at the low end of 6 meters, the Techs have so far almost completely avoided any contamination with CW. So, even if a Tech wants to get on and try to improve his CW ability, he is frequently stuck for someone to work with. So I proposed that Techs be permitted to use all Novice bands. This petition was sent to the FCC and given the number RM-1456. Nothing further has been heard of this petition except one letter from WAØLIK in support of it. If you think the idea is a good one you might send a letter to the FCC in support.

Phone operation on 6 meters is a good hobby, I grant. So is 2 meter FM and the other pursuits of the Technician licensee, but it is a real shame for the code to stand in the way of the fun and aggravation to be had on the lower bands. I enjoy 2 meters a lot, but I would be resentful if I were forced to stay there and not permitted to get on 20 meter phone.

A Solution to the Code Problem?

Since anyone who wants to can learn the code, it seems to me that a whole lot of Techs could be encouraged to become Generals if we first of all try hard to get them to improve their code speed, and secondly make it as easy as possible for them to do this.

How do we make it easy? We can step up the code classes in our radio clubs and get every 2 and 6 meter member to scrounge around the bands looking for Techs to get in the classes. Don't forget the coffee and doughnuts after the code sessions. Further, any operators on 2 and 6 can easily spend an hour or so a week sending code practice sessions on the air.

What do you send? I suggest that you look into the commercially prepared tapes since they are perfect code and of known speed. Move up into the band where you won't drown out regular contacts and set up a schedule of code practice sessions nightly or whatever you can handle. Keep them inflexibly on schedule so you don't lose the audience that you gradually build up. WIAW isn't the only station that can send code practice, you know.

Since a great many ops depend a lot more than they should on memorizing of the license manual to pass the exam, it won't hurt at all to begin each club meeting with a short tech session to help the members better understand the theory. Understanding gets you through the exams a lot better than memory.

Is your club doing everything it can to help its members up their license grade? Is your club honestly trying to recruit new Novice and Tech members and help them? Or is it like many that I have known, run by a handful of oldtimers who discourage newcomers? Don't look to the ARRL to suddenly start a nationwide PR campaign for the hobby...decide that you and your club will swing into action in your area to get more hams and move all members up at least one license grade.

73,
. . . W2NSD ■



My February editorial with respect to the new interim regulations for Canadian amateur repeaters has brought an unexpected spurt of responses from Canadians who feel that insufficient credit for the rules was given the Canadian repeater organizations. This is a point I certainly should have brought out, and I take this opportunity to do so. The rules adopted by the DOC (Canada's FCC) were a direct result of suggestions supplied by the Toronto FM Communications Association and the Ottawa Amateur Radio Club (and perhaps others). The point that was meant to be made in the earlier editorial was that the rules were based on the Buffalo petition – which is still a fact. The Buffalo petition served as a foundation from which a new draft was formulated by Paul Hudson VE3CWA and others. The draft became the DOC interim requirements for repeaters.

My apologies to the Canadian amateurs for my neglect. And a hearty well done to them for taking an issue and getting something done about it. We U.S. amateurs could learn something from this sequence of activities and cooperative efforts, I think.

A.E. Blick VE3AHU writes:

"...note that these are interim regulations and will not become formal regulations until they have been assessed as to their worth. Incidentally, you omitted to include the first regulation, which states: 'Applications for Amateur automatic repeaters will be considered on a case-by-case basis, as in the past.' This means that such stations will not be automatically licensed providing they meet the other requirements. Also, that the DOC has already been asked to drop the requirement that only the licensee be enabled to reset the repeater and consideration be given to an automatic device such as you mention."

C.H. Harrison K2QPF writes:

"...I feel you're taking issue with the Canadian interim FM repeater regulations 3-minute timeout requirement without complete analysis. The purpose of the automatic shutdown timer required by the regulation is obvious – to disable the transmitter in case of failure in the normal operational control circuitry. This requirement is desirable, and it should require reactivation only by the licensee. Your analysis overlooks the use of a second timer circuit which is part of the operational circuitry, and set for example at 2 minutes. It would terminate the carrier as in the usual sense, and reactivate automatically when our longwinded friend finally let go of the mike. The 3-minute timer would function only as it should; to completely disable the repeater until the licensee could analyze the cause of the malfunction, make necessary repair or adjustment, and return the repeater to service. The two-timer approach meets both the usual operational interruption of the longwinded channel hogger and the necessary safeguard requirements to reliably disable a malfunctioning repeater."

* * *

Since I always have a great deal to say but very little space in which to say it, I try to cut my editorial verbiage down to the barest essentials. As a consequence, I cannot always philosophize and ramble the way I'd like. And besides, with Dave Mann's Leaky Lines, 73 has about all the philosophy it can handle in any one month. But it seems to me that it is high time for at least a teensy bit of maundering, in defense of my position and 73's after Dave Mann's comments about the chastity of Technicians in general (February, Leaky Lines).

It is first prudent to say that I am editor – not a censor. Dave Mann's editorial material does not necessarily have to coincide with my opinions to be accepted for publication. He is entitled to speak his mind freely when he writes, regardless of how much I may disagree with the statements he makes. Which is as it should be.

Last-Minute Flash!

The FCC has prepared a "proposed rule-making" set of constraints with respect to oper-

ation of repeaters on the amateur bands, and is asking for comments before May 15, 1970. The complete text of the docket is not yet available, but an FCC representative listed the major points under consideration. They include relaxed logging requirements, automatic ID at 3-minute intervals, no repeaters below 50 MHz, mandatory tone control or whistle-on activation – all of which were recommended in RM-1542, a petition submitted in December.

But the FCC has gone a bit further by recommending that no links be allowed, no more than one transmitter be activated from a single receiver, no crossband operation, and no unattended repeater operation. The implications carried by these last items are weighty indeed, and warrant the immediate attention of every repeater owner, remote control operator, and prospective repeater/remote operator. If crossband operation is disallowed, there can be no city-to-city repeater interconnects. There can be no remotely controlled amateur stations, because all radio-controlled transmitters and transceivers involve UHF portions to link signals to and from the remotely controlled equipment.

The FCC deserves credit for making the effort to get repeater operation into the rules and regulations. But repeater progress will come to a complete standstill if the crossband and multiple-output recommendations of the FCC are upheld. The May issue of 73 will carry the complete text of the FCC's recommendation along with proposed alternative actions. Whatever you do, don't fail to get the May issue to see what's happening with repeaters. And if you have comments, you will have until May 15 to get them into the FCC office. 73 also will be filing a list of comments on this docket; these, too, will be published in the May issue.

If you plan on making comments on this important docket, don't do it yet. Start thinking about what you want to say. Discuss it at your next club meeting. Make notes. But read the FCC's recommendations before you file your comments. If you're an FM'er and you fail to comment on this vital issue, you'll have no one to blame but yourself if the FCC docket gets through unscathed.

* * *

There is a fairly common myth that I am beginning to hear more and more frequently quoted as truth. Since the myth affects me (and you), it's up to someone to talk about it. I don't know where it started, but I know it is known nationally. Worded in any of a dozen ways, it goes like this: *Amateurs who are not members of the League have no right to complain about the ARRL, its workings, policies, people, tactics, or structure.*

Now, I wouldn't worry if this were merely someone's misplaced ideology. I think it began as some League member's defense of League actions. But this month you will see it cited in Leaky Lines by Dave Mann, who has a reputation for "calling 'em right."

Lest the adage get perpetuated as a verisimilitude, I will risk sounding anti-League by debunking it. Whether I agree with the ARRL or its policies is immaterial. The fact remains that what the League does, what the League decides, what the League recommends – it does so not on behalf of its membership but on behalf of *the amateur radio community as a whole.* Since every nonmember is affected by every major ARRL decision, every amateur, member or not, has the right – and the duty – to be concerned with and get involved in League affairs.

Let's take the incentive licensing thing as an example. The League originated the proposal; but did it affect only League members or did it hurt us all? And how about the current Technician spectrum gift: Does it apply only to ARRL members or will all amateurs have to comply with any FCC decision based on the proposal? And the ARRL's repeater recommendations: Will they end up as League-only rules, or will all repeater owners and operators be forced to live with them as well?

As long as the ARRL's actions affect you as an amateur, you have an obligation to know what the League is doing and when. Your responsibility is not so much to get in the League, but to make your voice heard. As a nonmember, your right is even more intrinsic than it would be if you were a member. A League member pays his dues, which serves as that individual's approval of the way the League does things. His money (in dues) is a vote of confidence for "the system." Since the member is supporting the system, he has scant right to complain when he's knifed by the system – after all, he shares responsibility for its existence.

Ah, but the nonmember is another story. *He* does not back the system. He does not approve of the system. He does not believe in the system. Who, then, has *more* right to complain about being plowed under by the system?

If anyone ever tells you that you should join the League so that you could "effect change" from the inside, don't you believe it. Hams have been trying for years without success. But it doesn't take a genius to figure out that if every dissatisfied ham dropped his membership, the ARRL would either change or drop out itself. Your most powerful voice is NOT your ARRL membership. Rather it is the absence of it.

Don't make the mistake of labeling me anti-League, because I'm not. Neither do I appreciate the power of the League, however, to speak for hams who don't believe in the ARRL. I simply believe that *all* amateurs, League members or not, should have the right to vote on issues that affect all amateurs. Doesn't that seem reasonable?

. . . K6MVH ■

AN
EDITORIAL
by
DAVE MANN K2AGZ

Leaky Lines

1 DANIEL LANE, KINNELON NJ 07405

According to Yankee Legend, if you should encounter the ghost of Daniel Webster, he would ask just as in life, "How goes the Union, neighbor?" If there are truly shades and spirits, and I am not one to deny it, perhaps those which quickened the mortal coils of our hobby's pioneers might be asking, "How goes amateur radio, Old Man?"

Regrettably, the answer would not ring out so confidently and affirmatively as would our reply to old Dan'l. The state of amateur radio is not so sound as the state of the Union, despite irrationally optimistic claims to the contrary. Of course, all is not completely hopeless; things seldom are. But there is an air of demoralization which seems to be widespread, and this is evidence that we are disturbed and hagridden. We seem to be in an apprehensive mood, waiting for disaster to strike, from who knows what quarter. Like Tennyson's Light Brigade, there are "guns to the right of us, guns to the left of us," and we know not whence will come the volley and thunder.

Newly emerging nations eye our frequencies with covetousness. Commercial users intrude into our spectrum in blatant defiance of the assignment regulations. The communications facilities of our own armed forces create interference on the ham bands with impunity, and so does Voice of America. Municipalities devise pernicious covenants and restrictive codes, limiting or altogether prohibiting towers and antennas, and they sometimes even enact ordinances against our right to operate at all. It seems that although we are guaranteed the freedom to pursue happiness, this sometimes excludes the operation of a ham station!

In addition to all this harassment from outside sources, we are inwardly divided into sects and contending factions. After over fifty years of existence we find ourselves cloven into angry splinter groups, snarling and yammering at one another. At a time when we need desperately to be united, we are being hopelessly split asunder.

"How goes amateur radio, Old Man?"...Not so well, I'm afraid. We have witnessed dramatic changes in both the direction and character of ham radio in the past several years. This hobby started out as the sole province of the serious science-minded. It is now being contended that it has become the playtoy of entertainment seekers, just fiddling around with a novel and intriguing gewgaw. It is said that for every ham who is genuinely motivated by theoretical and technical aspects of the hobby, there are scores who possess only the most meager and sketchiest idea of what it's all about...who are capable only of plugging the rig into a wall receptacle, turning on a switch, and talking into a microphone.

This is an abominable situation, if it is true. If untrue, then it is a slander and a damnable libel. As for my own opinion, I tend to think it's untrue. There are literally thousands of amateurs deeply involved in the development of science and technology. The large laboratories at Bell Telephone, Bendix, ITT, Sperry, IBM, GE, and countless others, are engaged in a universally burgeoning program of research and scientific inquiry. And in every area of this rapid proliferation, on every level, conspicuously and meritoriously recognized for their contributions, there are radio amateurs. These people do not leave their knowledge and ingenuity outside the door to the hamshack.

Advances in the techniques of communications science, as in most other fields, have been accomplished largely by a select, determined group of innovators, far in advance of their contemporaries. A case in point: single sideband. Bell Telephone was involved in this field around the time of the first world war. Except for a tiny circle of knowledgeable hams, sideband remained practically unknown on the bands until the end of the thirties and the beginning of the forties. It did not become a practicality until after World War II. And even now, in 1970, it is not yet universally recognized as an acceptable form of communications. There are still hams who are resisting the mode and trying to shoot it down, because they view it as a newfangled fad which will never catch on. After almost four generations, imagine, single sideband is still regarded in some circles as a passing fancy, totally devoid of merit or value! Does this mean that the entire amateur community is decaying? Not at all. It simply signifies that some people resist change more tenaciously than others. It certainly does not entitle those who accept new ideas with eagerness and alacrity to feel contempt for those who do not do so.

We often hear of the impossibility of changing

human nature. While this popular cliche enjoys wide acceptance, it is only a half-truth. The human being has been in a constant state of change throughout his entire history. The changes have been slow and all but imperceptible. Yet they have occurred. There is a mighty inertia, no one can deny it, which prevents people from accepting change willingly. This is a personality characteristic, more pronounced in some than others. Even the introduction of inducements or penalties does not make it any the easier for people to accept change. In India, where there is unspeakable poverty coupled with tremendous overpopulation, the government sought a solution by offering a handsome incentive. They offered a significant monetary reward to all married men who would submit to an operation called a vasectomy. This is usually a painless and harmless procedure, requiring no hospital stay, and relatively simple. Despite the urgency of the situation and notwithstanding the great need for the money, very few men have come into the public health clinics for vasectomies. Incentives, like deterrents, are rarely successful. The death penalty, invoked for centuries in all the countries of the world as a deterrent to capital crimes, has rarely, if ever, prevented a murder!

There is slim likelihood that the entire ham population of the United States can be transformed into a community of scientifically motivated electronics specialists. We might as well demand that everybody who buys a piano must learn to tune and regulate it. Or that every driver must learn to service and repair his own automobile.

Well, what about this tendency of some amateurs to be contemptuous and disdainful toward the so-called "appliance operator?" First of all, we must expunge from our consciousness the idea that the standards of amateur radio are becoming degraded simply because some of us are not brilliant enough to homebrew our own stations. Those in the vanguard of the hobby are every bit as creative as their counterparts of yesteryear. It is merely that we have grown mightily in numbers since then, and the proportions have become altered. It is proper for hams to be made to conform to minimum standards of competence. But we must guard against the tendency to raise those standards to an unrealistic level. This road leads to the establishment of an elite caste; an aristocracy. And it's a certainty that no one, not the FCC, nor the ARRL, believes that all hams can become Extra Class operators.

In far too many circles there is a growing sentiment that a stigma attaches to anyone without an Extra Class ticket. It should be borne in mind that a licensed amateur, apart from the frequency restrictions specified by his grade, is just as good as any other amateur, whether he is an electronic genius or just a chap who is in the hobby for the sheer pleasure of it. If we fail to remember this, we are very likely to witness the loss of one of our most prized possessions; the wonderful cameraderie which has characterized amateur radio from its very beginning. And that would indeed be a tragedy.

* * * * *

As long as we are told that we are on such good terms with the countries of Latin America, through the "Good Neighbor Policy," and all the other huge spending programs that are helping to keep the ordinary people of our own land impoverished, I'd like to make a proposal.

Of course, I do not think it likely that this proposal will meet with strong approval in these countries, because I do not happen to believe we are on such good terms after all...in spite of all the fancy claims and contentions. I believe in that old saw about actions speaking louder than words. And I recall vividly the way Mr. Nixon was spat upon in South America...how the ships and property of American firms were seized...and many other manifestations of "antigringoism" in recent years. Mr. Rockefeller's recent factfinding mission was surely no exception either. It is clear that our stock is pretty low, unofficially anyway, south of the border.

Still, there appears to be a certain detectable cordiality between the hams of Latin countries and the hams of the United States. Because of this rather inconsistent ray of sunlight in the otherwise impenetrable darkness, I should like to suggest that someone try to prevail on our Latin American neighbors to stop running those ubiquitous phone patches on the low end of our 20 meter phone portion. This is probably the worst single source of QRM on our best DX band. And one of its most annoying features appears to be the constant participation of poorly modulated female voices, which frequency-modulate all over the place. When one of those gals starts delivering that rapid-fire Español, you might just as well forget about working anything within at least five kilohertz.

Since all South and Central Americans have privileges below 14.200, how about getting ITU or ARRL to make overtures to LABRE, RCV, RCP, RCB, etc., to get some sensible phone patch frequency recommendations, which will confine this troublesome annoyance to a more reasonable portion of the band.

Of course, I've noticed that about half the patches are made to the Miami area, and that rather complicates matters. I have a swell idea on that situation too, but I'm not going to dare to suggest it. I might find a line of bearded pickets, wearing fatigues, parading up and down in front of my house!

73, K2AGZ ■

Robert Grenell, ex W8RHR
3926 Beech Street
Cincinnati OH 45227

a NOISE BLANKER that works

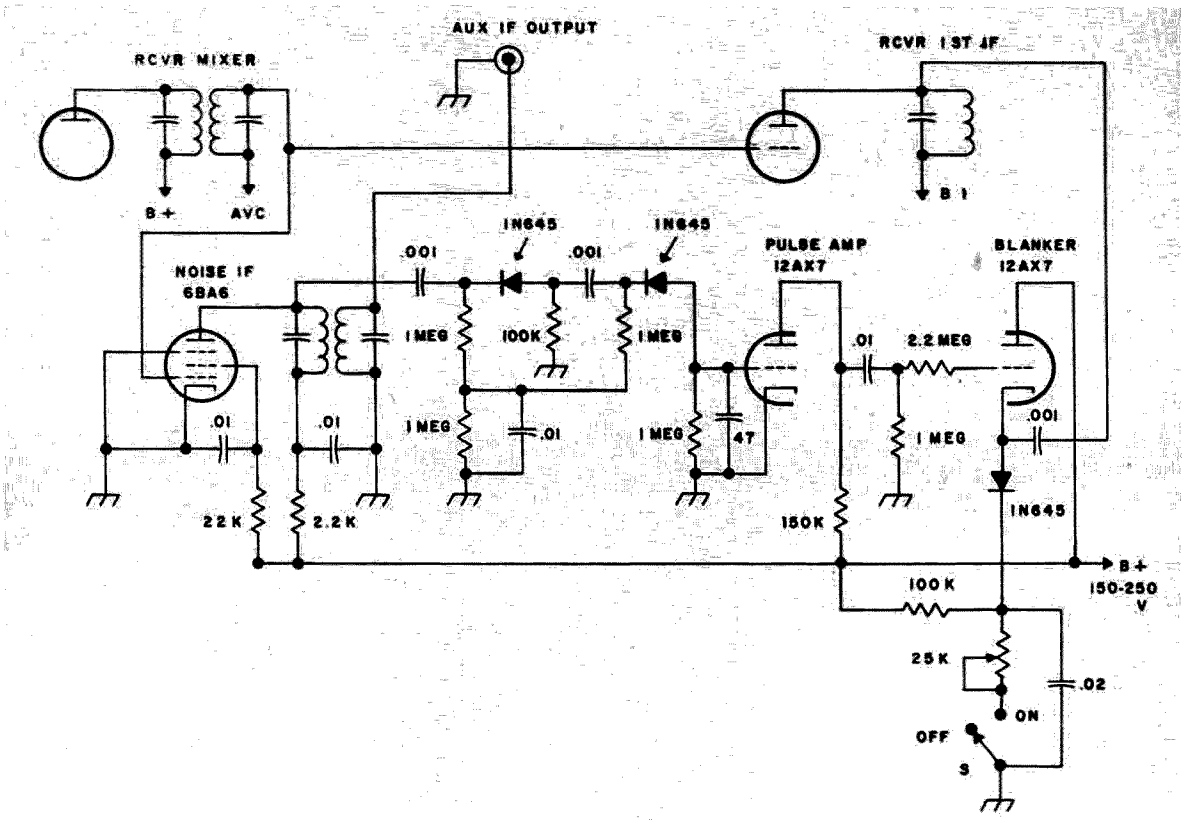
For pulse-type interference, there's no substitute for a blanker. Here's one that can be built up for less than five dollars...and it can be left in the circuit at all times without degrading normal receiver performance.

For several months now I've been experimenting with every imaginable type of noise reduction circuit. The result of extensive work with audio and i-f limiting and clipping was a growing conviction that the way to achieve truly effective noise reduction was to develop a blanker. Audio limiters and clippers all share one failing: they introduce harmonic distortion which reduces intelligibility and makes for extremely fatiguing listening over the long haul.

I-f limiting and clipping invariably reduce the signal level. Apparently, the more effective this kind of circuit is, the more loss it introduces. If it was to be necessary for me to build an extra i-f stage to compensate for this loss, why not go the route and develop a full blanker? The extra circuitry necessary would not amount to that much more than a clipper and extra i-f stage.

I came up with the following list of basic requirements after analyzing present commercial blankers, as well as a couple of circuits in the ARRL handbook.

1. Blanking must take place ahead of the selective stages to reduce ringing.
2. A minimum of 30 dB of blanking is a prerequisite, based on the performance of current commercial blankers, and



the claims made for other published circuits.

3. Compactness, simplicity, and ease of adjustment are obviously desirable.
4. The blanking action should not materially affect the signal.
5. The blanking action should be inversely proportional to the strength of the received signal.

All in all, five different circuits or combinations of circuits were breadboarded and tested. In most of them it was very difficult to secure a sufficiently low time constant to prevent audible "holes" from being punched in the signals in the presence of noise. In others, serious distortion of strong signals resulted from the inability to secure satisfactory inverse control of the blanking action, proportional to signal strength. Of all the circuits I built up, only one satisfied all the requirements adequately: R. L. Drake's blanker circuit as used in the R-4 series receivers. The purpose of this article is not to set forth an original circuit of mine, but to explain how this exceptionally fine blanker works, can be homebrewed, and integrated into existing equipment.

How It Works

An avc controlled 6BA6 amplifies the incoming *rf* signal from the first mixer and it is detected at D1. The avc control helps accontrol the level at which blanking action

pulse detector D2 proportionally to the strength of the incoming signal. D2 detects noise pulses exceeding the amplitude of the incoming signal, and the resultant negative pulses are used to cut off the first section of the 12AX7 instantaneously for the duration of the noise pulse received. This produces a positive pulse at the plate which in turn is used to turn on the second section.

When the second section is turned on, it draws current, forward-biasing the diode (D3) in series with its cathode for the duration of the noise pulse. When the diode conducts, it grounds the plate of the receiver's first i-f stage, instantaneously cutting off the signal while the noise pulse is present. Noise is literally chopped right out of the signal, while the signal itself remains virtually unchanged in its audible form, though it's really full of infinitesimal "holes." A piece of RG-58 is used to make the connection between the first i-f plate and the 12AX7 cathode through a .001 μF disc ceramic. When the blanker is off, diode D3 is heavily reverse-biased, preventing blanking or random clipping. The 25 kΩ pot is used to complish the desired inverse ratio between signal strength and blanking action. More control is derived from detection at D1; a portion of this voltage is used to reverse-bias

begins. I have used the secondary of the i-f transformer in the blanker to take off the i-f signal for a monitor scope.

Adjustment and Operation

There are no tricks to getting the blanker to work properly, and, if you've wired it correctly, you should find that it works perfectly as soon as three simple adjustments have been made.

1. Make sure that the blanker is off, and tune in a strong carrier — — your crystal calibrator will do nicely. Repeak the first receiver i-f to compensate for the connection to the blanker.
2. Remaining tuned to the carrier, adjust the i-f transformer in the blanker for maximum positive voltage at A.
3. Now find a signal of medium strength which is difficult to copy through heavy noise. (Perhaps you can have someone start your car and rev the engine to create some noise, if necessary). Adjust the 25 kΩ pot for sufficient blanking to enable you to copy the signal easily. You may be able to make the noise disappear entirely. This step requires some judgment, and you may want to repeat it several times under various conditions to be sure you've optimized the blanker's performance.

Once the above steps have been accomplished, you should find that you have better than 30 dB of blanking, probably more — plenty for even the worst conditions — without distorting the signal.

Now, get everything back together again, and be prepared to copy signals that you've never heard before. My QTH is a half block south of some high-voltage power lines. I guess I don't have to tell you what that does to weak groundwave signals on 6 meters . . . it obliterates them! Using the blanker, however, enables me to copy just about everything anyone else does, and a lot of it cannot even be detected (let alone copied) without the blanker.

The nature of this circuit is such that it can be left on at all times, if you wish, without degradation of receiver performance. It's only active in the presence of noise. It's very nearly foolproof, and it shouldn't take you more than an hour to build and install it. On top of that, it's plenty cheap. If you have any kind of junkbox at all, the whole works shouldn't cost more than three or four dollars. You'll find that this blanker will repay this minimal outlay of money and time many times over — and you'll be amazed at what you can dig out of the "mud" with its help.

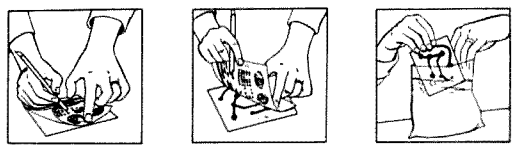
A few afterthoughts and suggestions are in order. I built the detection circuitry entirely on a piece of Vectorboard which is mounted to the chassis by a small angle bracket. I recommend this approach to save space, as well as for convenience, since this circuitry is quite awkward to mount on the usual tie-lug strips. It is important to retain the exact values of resistance and capacitance shown in the detector and blanking circuitry. Changing them could result in an increased time constant which might cause audible "holes" to be punched in the signal.

The method of applying avc to the blanker *if* may vary from receiver to receiver. This makes no difference, as long as a direct connection is made from the grid of the receiver's first i-f stage to the grid of the blanker's i-f stage. This will couple both signal and avc voltage to the blanker. Diodes D1, D2, and D3 can be nearly any general purpose silicon diode; but D3 must have sufficiently high ratings to handle the voltage drop and current through the 12AX7.

. . . W8RHR ■

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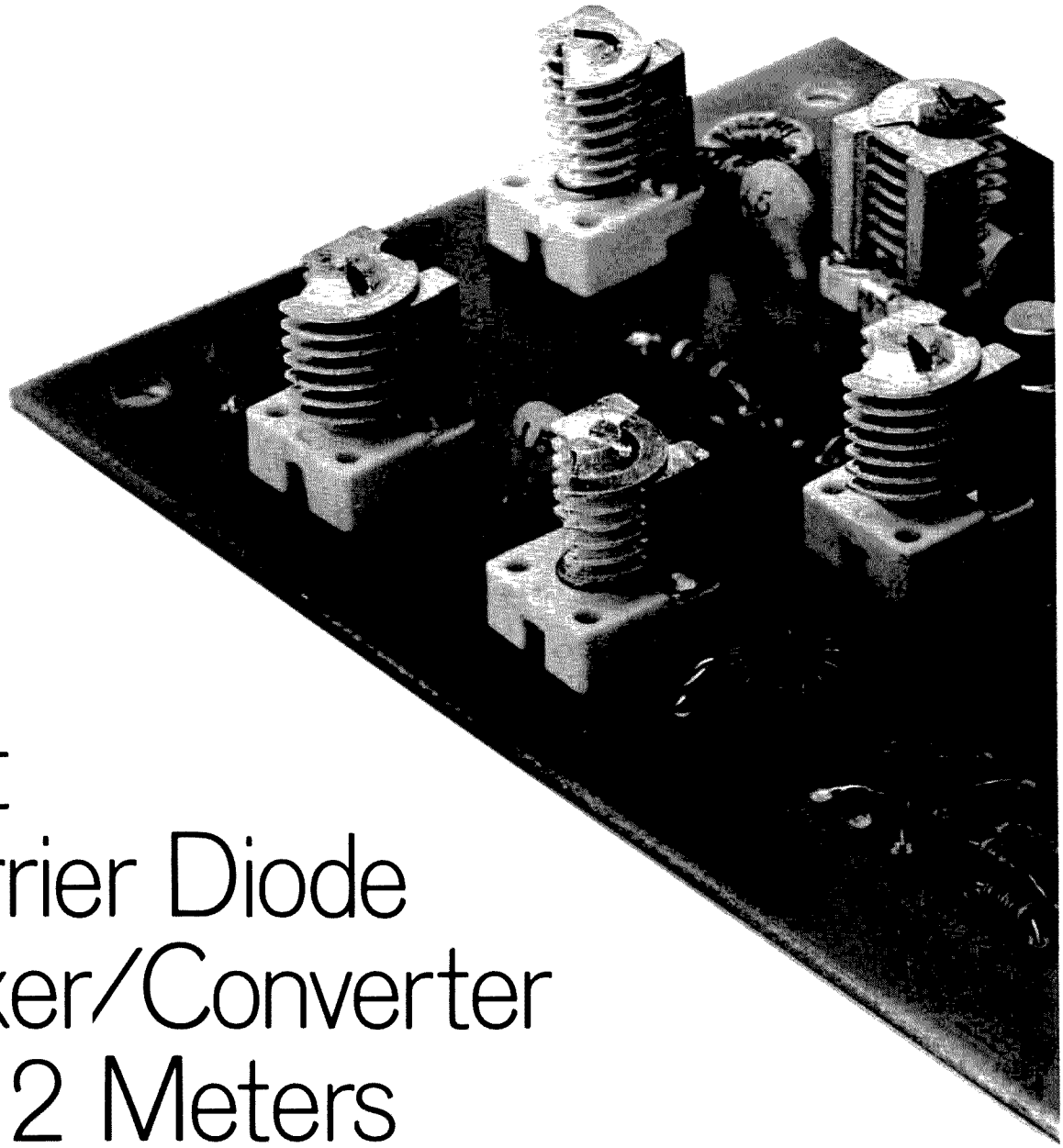
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Hot Carrier Diode Mixer/Converter For 2 Meters

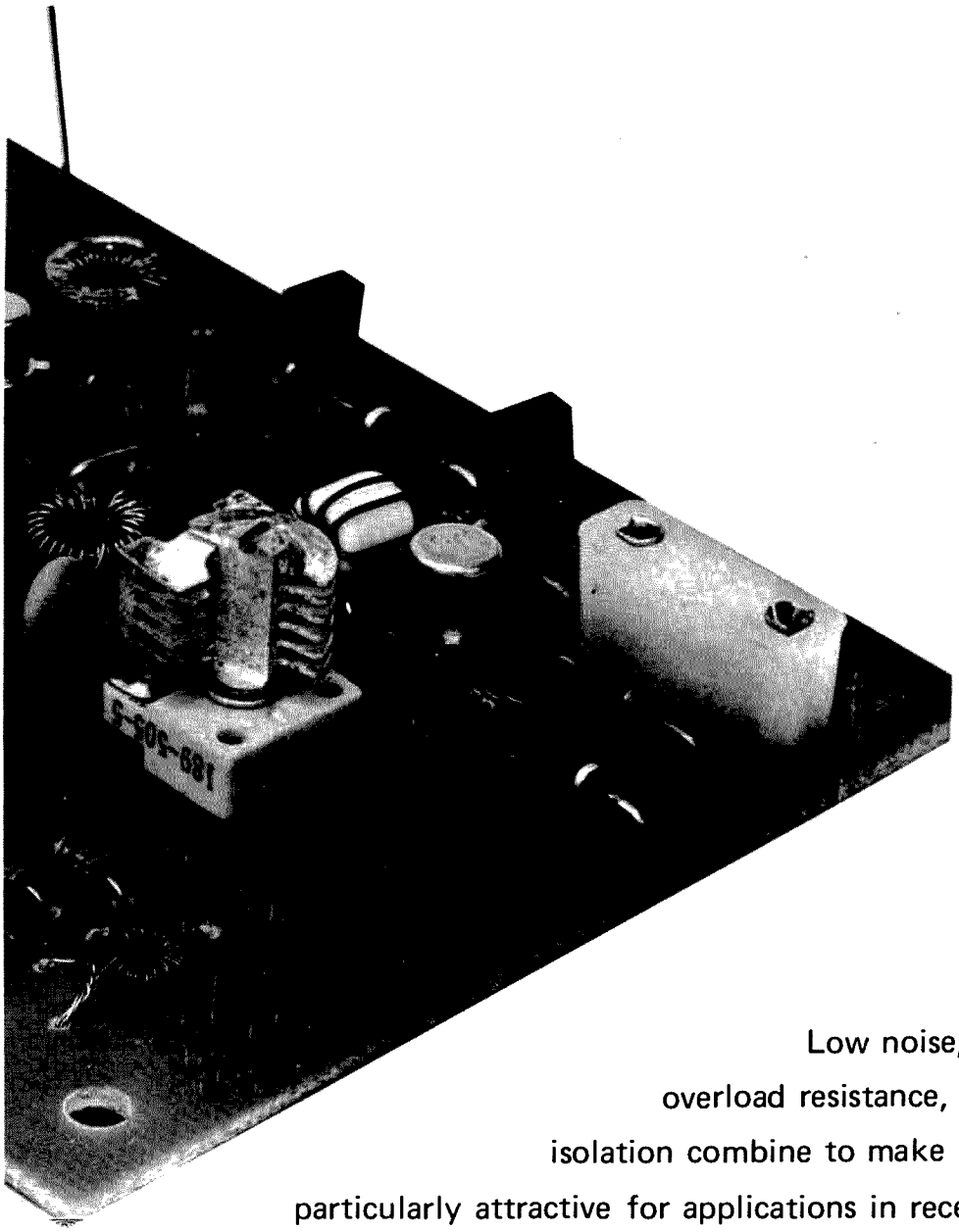
The double-balanced diode mixer using hot carrier diodes is enjoying widespread acceptance in commercial and military communications equipment. When properly applied, these mixers offer the designer many advantages compared to the conventional bipolar or field effect transistor approaches. The main advantages are:

- Very good overload resistance
- Low crosstalk and intermodulation products
- Good noise figure
- Excellent local oscillator isolation
- Construction simplicity and ease of duplication
- Can be made into a wideband device

This article describes an easily duplicated 2 meter converter which offers the latest in design concepts.

The detailed workings of the hot carrier diode and its operation in the double-balanced mixer can be found in the references. Briefly, the hot carrier diode is constructed using a PN junction joined to a metal barrier as shown in Fig. 1. This construction technique provides a diode with many advantages over the conventional point contact or silicon PN junction diode. These advantages include low turn-on voltage (410 mV), high UHF rectification efficiency, low diode noise, extremely fast switching times, and excellent diode-

William Ress WA6NCT
Box 903
Mountain View CA 94040



Low noise, high gain, excellent overload resistance, and a high degree of isolation combine to make the hot carrier diode particularly attractive for applications in receivers and converters.

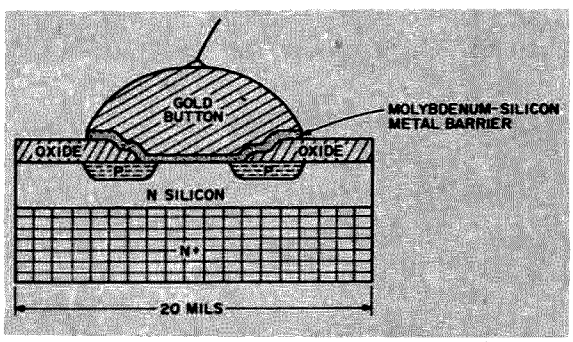


Fig. 1. Hot carrier diode junction profile.

to-diode uniformity.

The double-balanced diode mixer uses the variable resistance of the diode's on and off state to perform the mixing action, and offers excellent port-to-port isolation by using electrically balanced centertapped transformers. The noise contribution due to the local oscillator is also greatly reduced due to the electrical arrangement of the transformers. Since the diodes and the local oscillator offer no significant noise contribution to the mixing operation, the mixer is essentially a noiseless passive device which has a conversion loss. This conversion loss (typically 5–7 dB for mixers of this type and frequency range) appears as a resistive attenuator when used in a down-converter application. This mixer is a broadband device; therefore, to change the i-f output frequency to suit your requirements, only the local oscillator

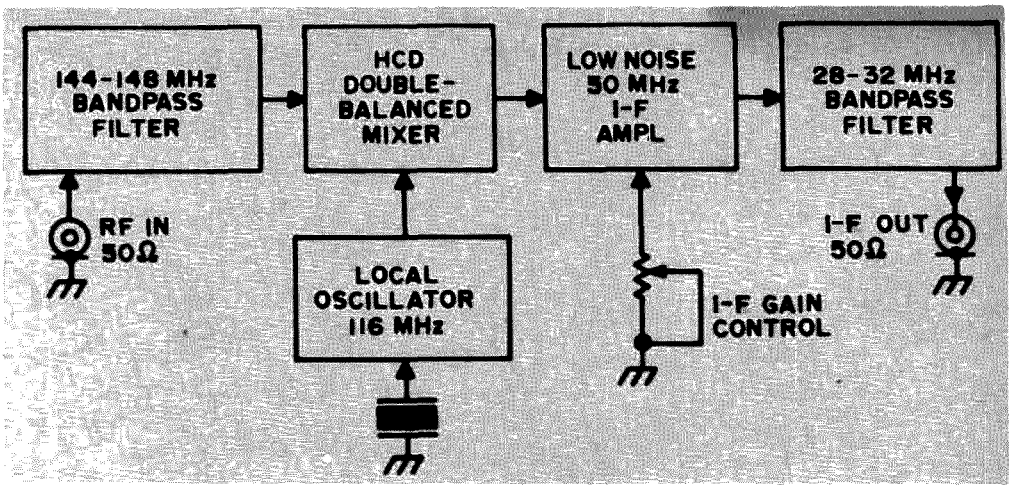


Fig. 2. 2 meter converter block diagram.

frequency and the i-f amplifier center frequency need be modified.

The block diagram of the converter is shown in Fig. 2. It starts with a bandpass filter centered at 146 MHz. This filter is a critically coupled double-tuned circuit which provides a bandwidth of 6 MHz and an insertion loss of 1 dB. It is necessary to use a bandpass filter ahead of the broadband mixer to eliminate the noise power that would be contributed by the images. The response of the filter is shown in Fig. 3.

Following the input filter is the double-balanced diode mixer. It uses a computer-matched diode quad; the Hewlett Packard HPA-5082-2805 available from your local HP-Neely sales office for $4.40. The quad is composed of selected HPA-5082-2800 diodes which can be used and are available for 99¢, but the matched quad will provide

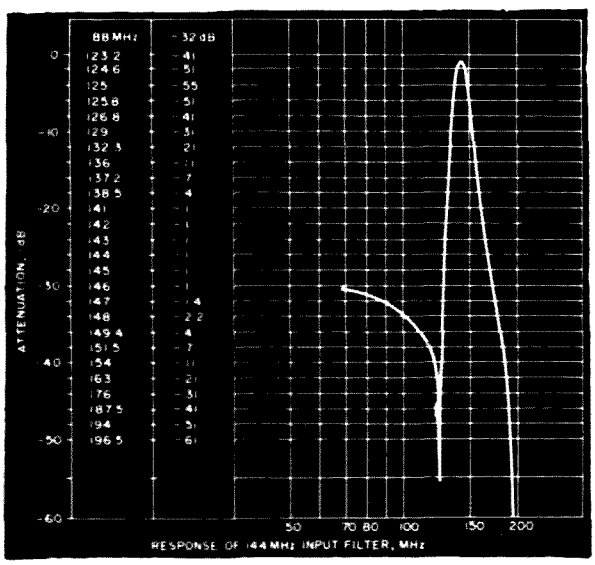
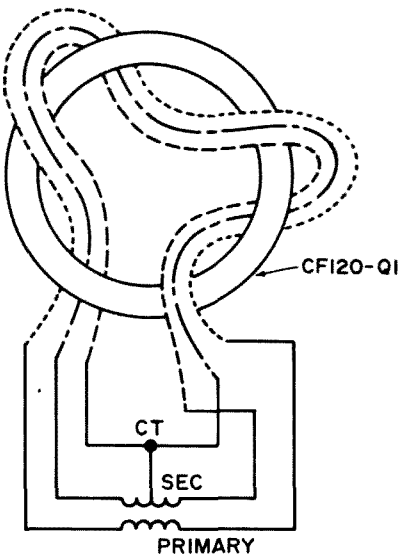


Fig. 3. Response curve showing attenuation vs frequency.



(WIRES SHOWN UNTWISTED FOR CLARITY)

Fig. 4. Toroid winding.

better mixer balance and a lower conversion loss, so it will be worth the extra money. The toroids used are Indiana General CF-120-Q1's available from Newark Electronics for $1.20 each. They are wound with 30, 32, or 34 (AWG) enamel wire. The windings on the toroid are shown in Figs. 4 and 5. Care should be made to insure that the proper winding interconnections are made.

The 30 MHz i-f amplifier following the mixer is a low-noise FET stage. It uses the

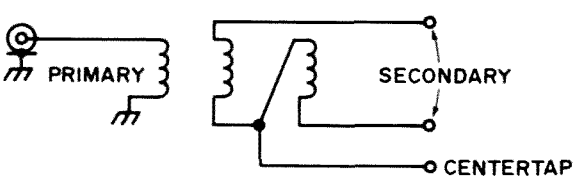


Fig. 5. Schematic of the trifilar toroid connections. (The three windings should be twisted together before winding onto the core.)

RCA 40602 dual-gate FET which exhibits high gain, low noise, and very little reverse capacitance. This low reverse capacitance allows you to build a high-gain amplifier at this frequency without having to neutralize. The second gate provides a convenient way of varying the stage gain so that the converter can be properly matched to your receiver i-f. The gain of this stage is 28 dB with the i-f gain control at maximum and 0 dB at the minimum position. The output of the FET is a double-tuned circuit centered at 30 MHz. It provides a flat response from 28 to 32 MHz with high skirt selectivity. It should be noted that the i-f amplifier following this type of passive mixer must have the lowest noise figure possible as it will directly add to the overall converter noise figure. The use of the FET in the i-f amplifier also allows one to take advantage of the FET's overload capabilities and low crosstalk and intermodulation products.

The mixer's oscillator injection is obtained from a "no multiplication" local oscillator. It uses a seventh overtone crystal at 116 MHz in a common-base Colpitts

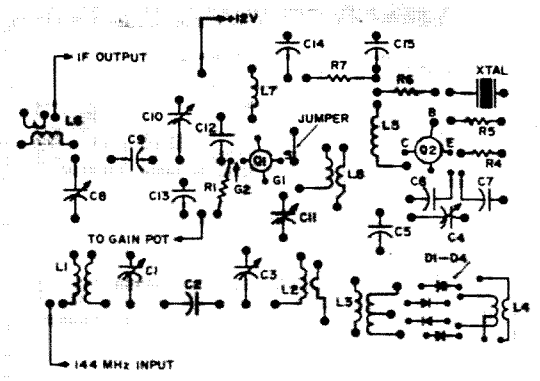


Fig. 6. PC layout (component side of board).

oscillator circuit. The cost of the crystal is about $7.50, but it eliminates the multiplication stages and tuneup required for the tripled 38.666 MHz approach. The "no multiplication" approach also eliminates many undesireable harmonics from being fed into the mixer which would cause unnecessary image and "birdie" problems. This oscillator circuit is easy to get started and it will supply the mixer with about 10 mW of drive. This circuit has been used with crystals from various manufacturers

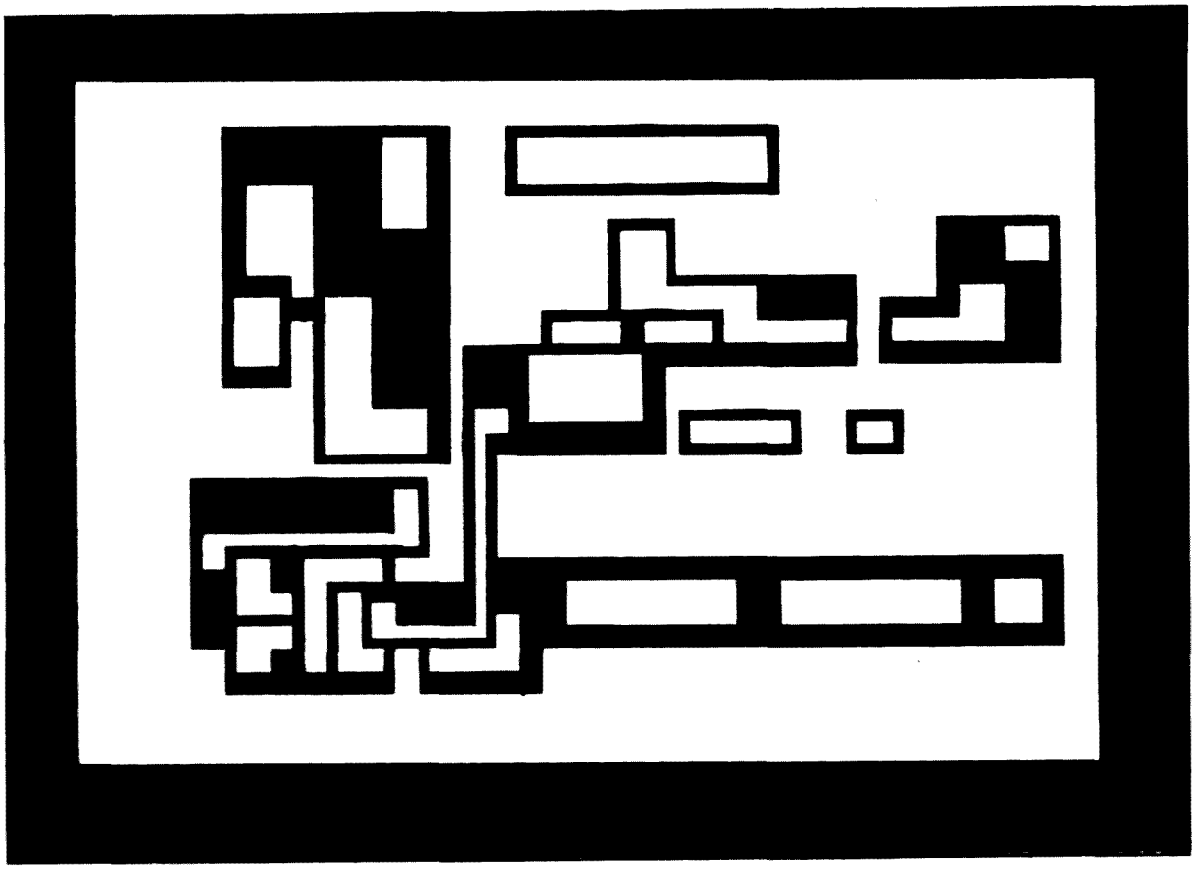


Fig. 7. PC layout (copper side of board)

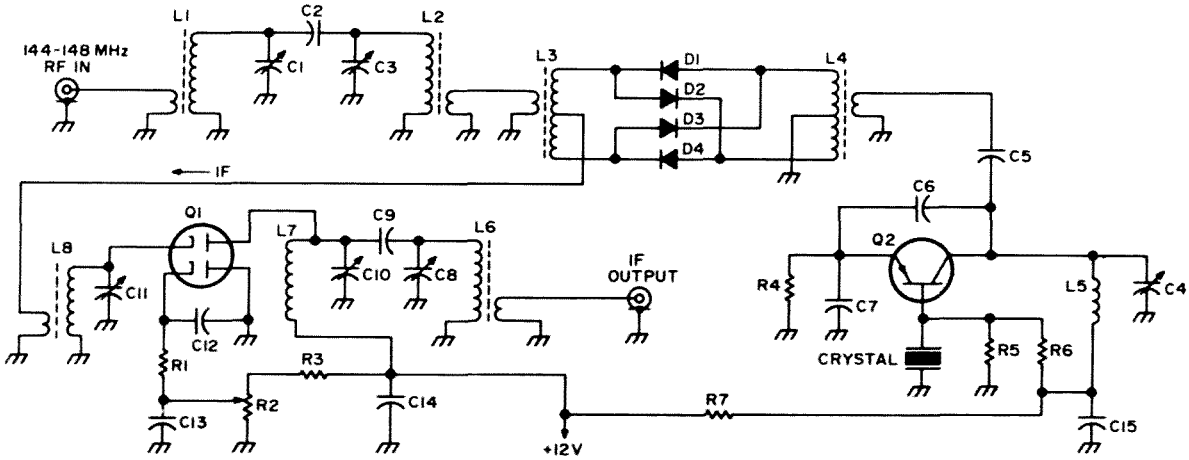
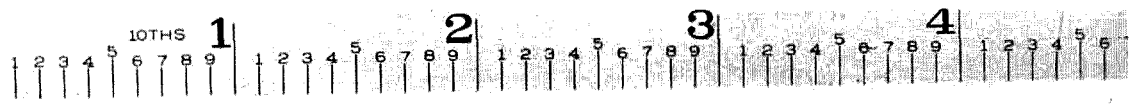


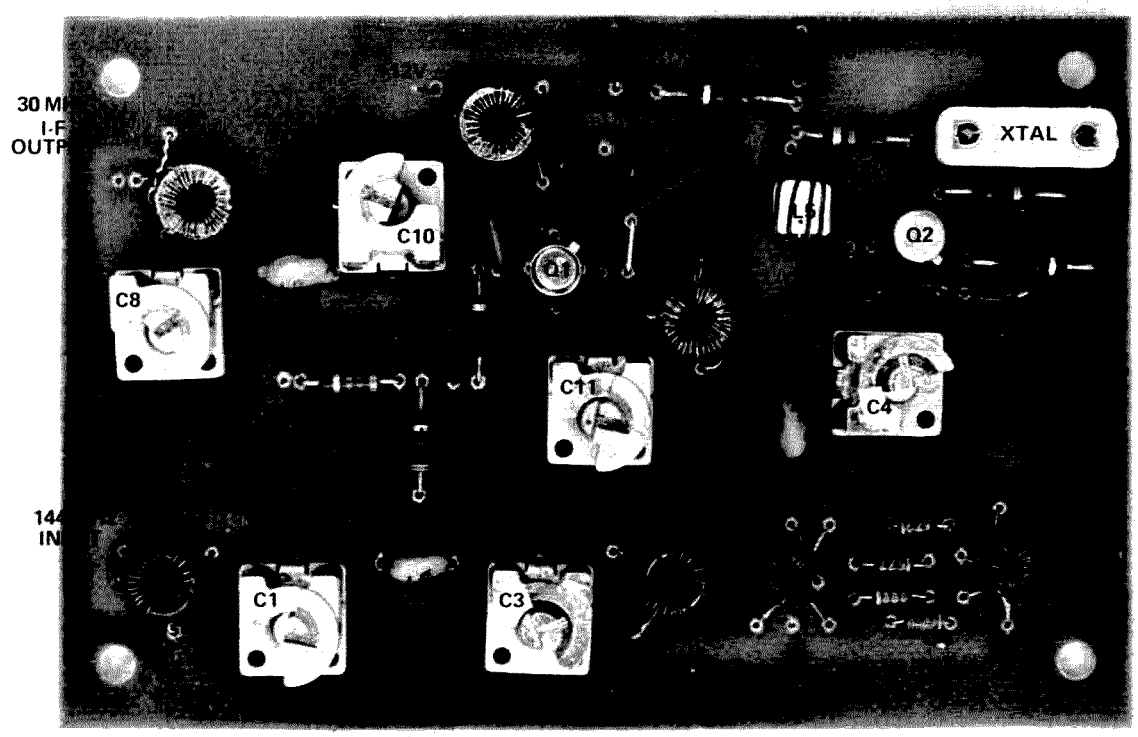
Fig. 8. 2 meter hot carrier diode converter.

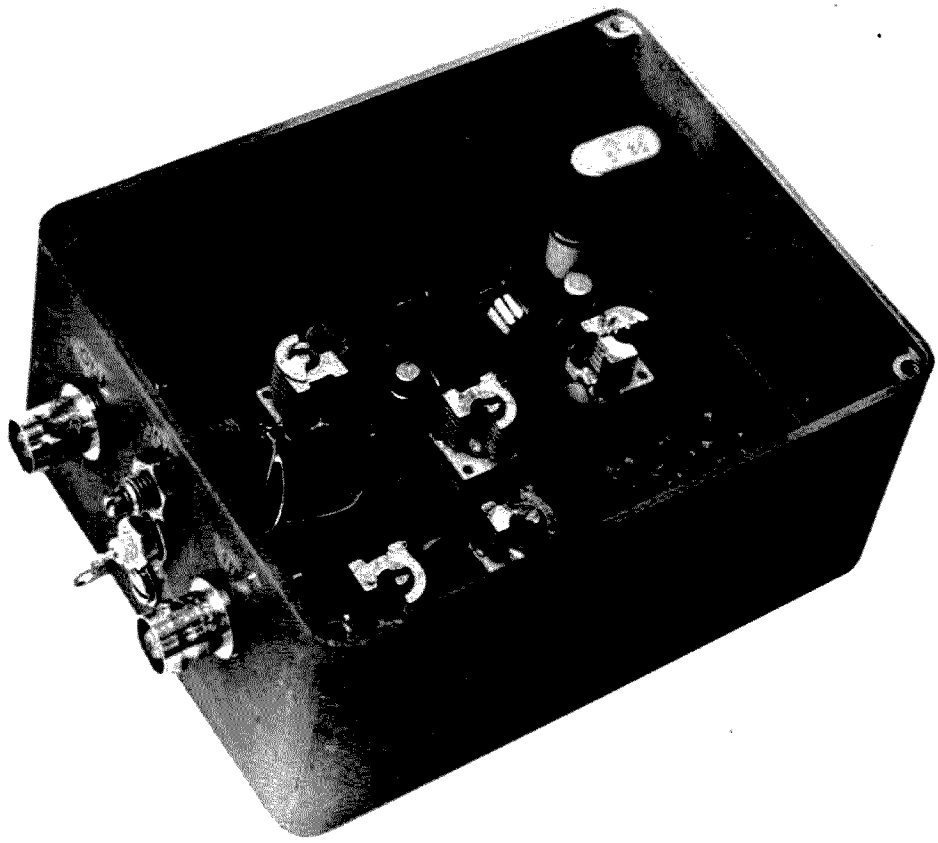
and by others in their converters and it always plays right off. So don't fear getting this 116 MHz oscillator circuit to work.

The printed circuit board layout is shown in Figs. 6 and 7. By using it and the components recommended, duplication of this converter should not be a problem. The use of a passive mixer and an i-f amplifier that doesn't require neutralization makes tuneup very simple.

Alignment of the down converter is a simple matter. First, get the oscillator working and then peak the input filter and the i-f amplifier with a 2 meter signal. The oscillator is started by tuning C4 and using a wavemeter or the diode position on a grid dip meter as a signal indicator. Once you've established that the oscillator is running, feed a 2 meter signal into the converter input and peak the input filter and the i-f







amplifier for a maximum S-meter reading on your receiver. Optimum flat bandpass characteristics can be obtained for the input filter and the i-f amplifier if a sweep generator is available. Once the circuits are tuned, the i-f gain control is adjusted until the converter noise just overrides the receiver's noise.

Noise Figure

Since we are dealing with passive devices, which have insertion loss instead of gain, this loss is treated like an attenuator. The input filter, with insertion loss of approximately 1 dB, is followed by another device, the mixer, which has an insertion loss of about 6 dB (for a total of 7 dB). The noise figure of the i-f amplifier is 2 dB and, since a total of 7 dB attenuation appears ahead of it, the overall noise figure of the converter is 2 dB noise plus 7 dB attenuation – or 9 dB total.

The completed converter has a noise figure of approximately 10 dB, which will be more than adequate for local ragchewing, mobiling, and FM repeater work. Naturally, for weak-signal work it will be necessary to put a low-noise rf preamplifier ahead of the converter. The image rejection is determined by the input filter and for the worst-case image band of 84–88 MHz, it will provide 30 dB rejection. All other images are down better than 50 dB.

PARTS LIST

C1, C3, C4, C8, C10, C11: 1.7-14.1 pF; EF JOHNSON 189-505-S; 60¢ each.
C2, C9: 1.5 pF NPO Ceramic
C5: 2.2 pF NPO Ceramic
C6: 3 pF Silver Mica
C7: 15 pF Silver Mica
C12, C13, C14, C15: 1000 pF Disc Ceramic
R1: 2.2K ¼W
R2: 50K Potentiometer
R3: 47K ¼W
R4: 100K ¼W
R5: 2.7K ¼W
R6: 10K ¼W
R7: 1K ¼W
L1, L2: PRI 10 turns No. 26 on Micrometals; sec 4 turns No. 26 on cold end.
L3, L4: 12 turns No. 34 Tri-filar on Indiana General CF-120-Q1.
L5: 7 turns No. 26 on Micrometals
L6, L7: 24 turns No. 28 on Micrometals; L7 has a secondary winding of 3 turns.
L8: 24 turns No. 28 on Micrometals; primary 7 turns No. 28 on cold end.
D1, D2, D3, D4: Hewlett Packard HPA-5082-2805 diodes.
Q1: RCA 40602
Q2: RCA 2N5187

The converter will form an excellent base around which a top performing and versatile weak signal system can be built. You'll be pleasantly surprised by the clean quality of the converter. There will be a scarcity of birdies and images and it will be harder for strong nearby signals to overload the converter. . . . WA6NCT ■

EXAMINING FM REPEATER OPERATION

Robert Kelty WB6DJT
2661 Carol Drive
San Jose CA 95125

Interest in amateur FM repeaters has grown in less than ten years to be a significant segment of VHF activity to which even diehard traditionalists are now turning. Hardly a major community exists around the country in which there is not some FM operation; and now, equipment suppliers are beginning to give serious attention to FM'ers. Repeaters grew up under regulations not originally envisioning such operation, yet were recognized in general as remotely controlled stations. Traveling around the country, one readily sees that each operates in a slightly different manner, with groups tailoring their nets to their own requirements.

Until late 1968 the ARRL, amateurdom's "official voice," hardly knew what a repeater (or remote base) was, and League publications carried little more than occasional mention. Meanwhile growth and interest has continued. Operation of remotely controlled equipment for group benefit has a certain cost reality; a successful repeater calls for organized support, often in club form, to insure permanency. In California a relay council was organized as early as 1966 to administer matters such as frequency coordination, standards, and to do advance planning at a level that would benefit all repeaters. Throughout the country individual groups began interfacing or providing means to tie to each other and the ARRL Board of Directors saw that repeater people were serious about what they were doing and had the finances and organization to continue growth almost without limit. The publication of an FM Repeater Handbook[1] in

[1] Radio Amateurs FM Repeater Handbook, Ken W. Sessions, Jr., Editors and Engineers, New Augusta, Indiana.

1969 gives adequate evidence that remote operation by VHF and UHF amateur operators from rf-advantageous permanent locations is indeed here to stay.

The importance of a large new segment of amateur interest was wisely recognized by ARRL directors almost belatedly and, seeing that the "Buffalo Petition" was a seriously considered necessity, they moved in 1969 to appoint a special committee to study repeater activity with an eye toward recommending FCC rules changes that would both correct inadequately written sections and enhance operation. In addition, the board voted for ARRL involvement at headquarters and for inclusion of a chapter on repeaters in the yearly handbook to stimulate interest. A separate League VHF handbook is still under consideration.

In 1970 the committee's final report and recommendations will be released and hopefully rules changes will be implemented to permit operation closer to realities which have often been discussed by "repeater people." It is to these proposed changes that we now turn our attention.

Getting the License

Licensing of a remotely controlled station has never been a major hangup, the procedure being almost adequately described in section 97.43 of Regulations. The applicant conforms in part by checking certain blocks on his standard form 610B and by submission of block diagram and description of proposed means of controlling the installation to prevent operation not in compliance with regulations.

For the most part, systems run cleanly and the intent of regulations is not circumvented purposely to the detriment of the service. Still, repeater operation is more closely comparable to PSIT[2] radio services rather than to "ham" type activity. Fixed, portable, and mobile operation on fixed frequencies naturally became abbreviated to the point that callups, logging, identifying, and control methods are somewhat different from that in which an operator hunts for a QSO with someone he may not know. Net operation always seems to be a cohesive that fosters good operating procedures because of the necessity of a good "net image" in the eyes of outsiders. The occasional maverick soon finds himself unwanted.

One of the rule sections being carefully considered by the repeater advisory committee has been licensing. It has been agreed in repeater circles that the present "remotely controlled station" category has too many implied restrictions.

In essence, a remotely controlled station is not described as a mobile relay (repeater), one which is used to extend mobile-to-mobile communications range. It appears that this valuable and now very popular application of equipment was not considered in original rulemaking and that the authors only thought in terms of remote base operation by individuals. The Commission has nevertheless considered applications on individual merit, granting licenses where the intent and presentation was in order. Hundreds of such installations are now in operation on prime coverage sites serving many thousands of VHF and UHF enthusiasts.

It is difficult to imagine that there are any licensees who don't recognize that the letter of the rules under which they operate is not being complied with. Many have tried to minimize this enigma by licensing as many as 38 individual control points,[3] licensing wives who are at home most of the day, placing control stations at places of business where monitoring can be accomplished, relying on an unlisted telephone which will deactivate the transmitter when dialed, or via a primary power control switch arrangement at a 24-hour answering service which can be turned off by an unlicensed operator on request. All are honest attempts to comply as closely as practical. All are clever interpretive applications.

[2]Public Safety, Industrial, Land Transportation, often called "commercial" land mobile.

[3]Grizzly Peak VHF Amateur Radio Club, Richmond, California (WB6AAE).

Properly licensing and operating a station is even more involved when one considers not only the VHF mobile relay but interfaced UHF, interconnection to other stations, extension to multiple pickup receivers, or selectively keying transmitters. Configurations take many forms.

A workable solution and one which the California Amateur Relay Council endorses is to establish two additional categories of station under Section 97.3, Amateur Unattended Station and Amateur Repeater Station, then license on a per case basis as described under 97.43 (with certain modifications), submitting proposed configuration as at present. Licensing procedures would thus be preserved more realistically.

Control Methods

Maintaining control of unattended transmitters has been a handicap to licensees because of rules rather than equipment. Monitoring of the emissions of remote transmitters from the licensed control point(s) plus provision of a 220 MHz (or above) control path (or wireline) places restraints on a system unnecessarily. Unattended-station users have reached a point of proficiency and sophistication to allow control on the VHF input channel above 50 MHz with adequate protection against stuck transmitters, deviations from terms of license, or undesired radiations. Timeout devices, carrier coding, or other similar devices are this protection. Although station responsibility must remain with a "trustee of license," he can easily record individual stations who normally use the remote station in his log once or the occasional transient at each occurrence.

Currently popular methods of insuring that only authorized stations perform the control function (placing the remote transmitter on the air) include "dial up" for the period of use, number sequencing known only by authorized stations, and "per transmission" coding (pulse tone or continuous subaudible). Occasionally rumblings are heard concerning discrimination against outsiders or maintaining "closed" relays but trustees are merely maintaining control while insuring that cost sharing is in effect. Purists new to VHF repeaters seldom see that the co-op station is a relatively new concept borrowed from "business radio" until they realize dollar investment in equipment, maintenance, and club costs.

As for suspending radiation in the event of deviation from terms of license, a means can be provided and described in license applications. Certainly a trustee is clever enough to meet this requirement in his own way when held responsible. Amateurs are marvelously self-policing by nature and it has been proved repeatedly that the willful violator has no regard for rules, ethics, or propriety no matter what constraints are placed on him. Responsibility can be enforced should such need arise by virtue of the trustee's application, license grant, and terms of license.

Identification

Despite relaxation of identification requirements in the past two years, many amateurs, especially those who have operated below 30 MHz for long, tend to dual identify, give location, and identify again. At one time this may have been practical and of some value, but today – especially when operating through remote VHF equipment, which usually is devoid of marginal signals – there is little need to prolong the callsign ritual. Operators who feel insecure or wish to prove to listeners their superb range will continue to take opportunities to give mobile locations frequently but the practice seems merely for display. Ragchewing will still be popular but has taken a slightly different hue and those operators who are still yearning for a wall certificate for staying on the air for extended periods have found that laudatory rewards are hard to come by on FM.

Repeater people have discussed extensively the time interval that should be required between callsigns and it is generally felt that 10 minutes is not asking too much. Still, the operator who becomes engrossed in multiple-party exchanges sometimes lets one of these intervals slip

by. The fluid pattern of who is talking to whom is often difficult to confine in time frames.

Identification of remotely controlled transmitters at intervals, in voice or electromechanically is another area describable in shades of gray. A remote base can be identified without confusion, as can a repeater; however, when several people operate the station, who gives the assigned call? Or on a remote base with a UHF "up" and "down" link, is identification of the down link to be made? Or for that matter is it to be continuously monitored? Another level of interpretation is added when more than one station is operated simultaneously or interfaced. Most of us just tend to throw in a series of callsigns and let it go at that, for better or worse.

In "preliminary study committee" discussions, three-minute ID of repeaters has even been proposed for rules although saner types still feel little need to identify equipment to death unless they feel insecure among their listeners. The FM Magazine petition, a year in the making, is now before the FCC as RM-1542. This petition suggests a three-minute ID, too, but on a slightly different – and more reasonable – basis: it would have the ID take place after each three minutes of actual on-the-air time, rather than each three minutes of overall operation. But I think the most practical procedure would be to authorize "no announcement of callsign when station is operated as a repeater or unattended station," similarly to other land mobile licensees who request this attachment to their terms of license. We identify our own stations during exchanges, and the remote equipment carries this intelligence along with adequate indication to the ear that one is listening to a remotely controlled transmitter. Making identification permissive rather than mandatory, as Jay O'Brien (ARRL repeater advisory committee member) suggests, still leaves a group with the ability to advertise who they are. Or if they really like to fool around with identification, there probably isn't anything wrong with interesting "canned" announcements done by well known amateur voices as some Southern California addicts like to do. This type of creeping "Hollywoodism" is native to Southern California where it somehow seems fitting.

Station Logging

Log requirements for unattended stations are not defined in FCC Rules, Part 97.103 except that one could contend that a control station should comply with each subsection and record time of each sequence of communications, signature of operators using the station, and location of stations transmitting. To anyone who has listened to a repeater, even briefly, this is a tall order. Actual logs that might be examined reflect a very liberalized application of our outmoded rules for this type of operation, where several mobiles might be involved at any one time, traveling various routes. Hand-carried portables are becoming quite popular and present another variation. Minimizing of logging requirements is certainly in order.

It is close to universally agreed that recording time of retransmission capability, technical parameters such as power, frequency, and emission, date and time of changes of items to be logged, and signature of operator making adjustments comprise an adequate log. Redundancy of items that appear in individual logs should be eliminated. RM-1542 would have a "maintenance" log only, filled in during periods when the repeater site is visited for service or repair.

The ARRL study group has done a comprehensive job of evaluating the amateur repeater picture, drawing from its members as well as from discussions with repeater groups around the country. While this review reflects quite closely the interim reports of that committee, final report has not been completed and probably won't be until early spring.

We who have been involved with repeaters for the past decade look forward to rule changes by late summer of 1970 with the realization that by so doing the FCC will be formally recognizing the importance of this dynamically growing segment of amateur activity.

. . . WB6DJT ■

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a REPEATER CONTROLLER

The myriads of mechanical contrivances that repeaters inevitably wind up with can be replaced with transistor equivalents...with a resulting increase in system reliability and decreases in headaches for the repairman.

After operating an amateur repeater for several years it became quite apparent that the majority of our repeater failures were caused not by a malfunction of either the receiver or the transmitter, but by a failure of the carrier-operated relay (COR), the three-minute mechanical timer, or the *hang-in timer.*

We have been using the standard Motorola tube-type COR with a Telechron drive three-minute timer and an Agastat dash-pot timer for hang-in. We often had trouble with the Agastat mechanically shaking things loose in the repeater and middle-of-the-night wife-type complaints about the noise, particularly when a mobile was putting in a "picket fence" signal at 2 a.m. It's like waking up to a machine-gun.

In an attempt to eliminate the problem associated with these mechanical devices we began to work toward a solid-state system. Our objective was to reliably key the transmitter on both weak and strong signals, without any buckshot, and to provide carrier hang-in, automatic tone CW identification and a three-minute timer. We accomplished this with a Schmitt trig-

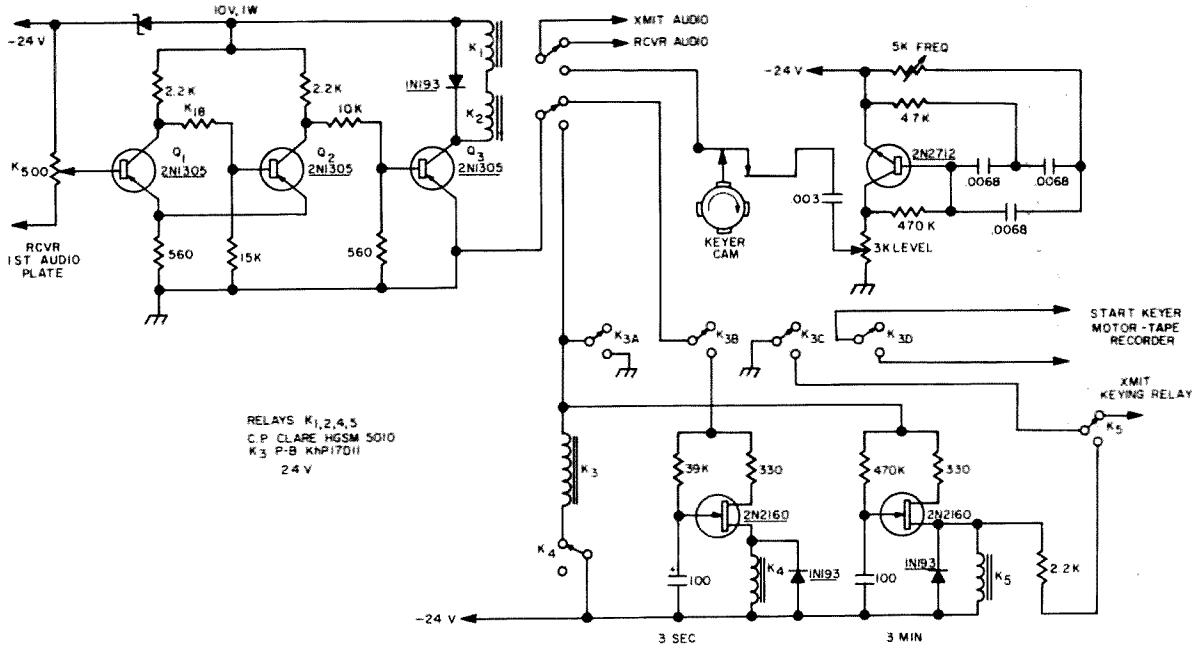


Fig. 1. Schematic diagram of repeater controller circuit.

ger operating from the change in plate voltage of the first audio amplifier in our GE Progress Line receiver.

The Schmitt trigger requires only a 2V change in a negative direction to switch on properly, due to the regenerative feedback of the direct emitter coupling. (Refer to Fig. 1.) Once it has switched, Q3 sees the 8V change on the collector of Q2 and turns on, causing series-connected relays K1 and K2 to close. This circuit and the relays have the capability of switching at speeds up to 20 kHz. Once K2 has closed, K3 latches itself closed through contacts K3A. When this occurs, the transmitter is keyed via K5 and K3C.

Since relay K3 is latched closed, when the received carrier drops out it cannot open and let the transmitter turn off; however, when relay K2 opens, voltage is applied to the three-second timer via K3B and K2, which causes the 100 μF capacitor to charge through the 39K resistor. When the capacitor charges to the breakover voltage of the 2N2160 unijunction transistor, it then discharges into the coil of relay K4 causing its normally closed contacts to open momentarily and allow relay K3 to reset.

In the interim period after K2 opens, K1 has switched the transmitter audio input from the receiver to the CW keyed tone for identification purposes. This provides an automatic "ident" every time a mobile releases his microphone. It also eliminates the squelch-tail noise burst from the reeciver since the Schmitt trigger will reset faster than the receiver squelch.

In the event an input signal is present in the receiver for longer than three minuts, another unijunction transistor timer — which starts its timing cycle as soon as the transmitter is keyed — will time out and latch relay K5 closed. This shuts down the transmitter until such time as the input signal is removed and the three-second timer times out and resets relay K3. When relay K3 opens, both timers are instantly reset (no waiting for the gears to unwind in a mechanical timer).

The tone oscillator frequency is set to 1800 Hz to allow its use for actuating other devices in the control link system on 450 MHz. A potentiometer can be bridged from the tone oscillator output to the transmitter audio input to provide a 1 Hz deviation of the transmitter on top of the receiver audio. This tone can then be

used to key a 450 MHz link to another site.

In our system we utilize a 2 meter receiver feeding a 450 MHz transmitter (which keys a second 450-MHz-to-2-meter transmitter at a remote site). The tone gives us tone control of the remote transmitter as well as auomatic identification of both transmitters. We can also control the remote site by use of 450 MHz from our control points; in fact, we occasionally operate crossband to 450 MHz mobiles.

Our repeaters were built by using old, wide-drawer, GE MTS units and replacing the vibrator transformers with ac transformers. The controller mounts where the Secode was installed originally. It makes a nice compact repeater that can be carried in one hand.

Construction

The PC board can be laid out by first cutting the board to size and then drilling the required holes at the proper locations. Then, using the *rub-on* PC board decals, the proper circuit layout can be made easily right on the copper. If you have relays which are electrically similar to the photo of Fig. 2, simply drill holes and position the layout to fit your parts.

After laying the board out, wipe the board with a cotton sponge soaked in mineral spirits to remove the excess adhesive (which tends to ooze out from around the rub-on decals. This will give much sharper lines after etching in ferric chloride. To remove the decals after completion of the etching, we used a piece of steel wool (which also cleans the copper and makes soldering easy).

The board layout (shown full-size in Fig. 3) was made to fit an Amphenol 143-015-04 edge connector; however, the wires to the repeater can be soldered directly to the circuit board if desired. It does facilitate servicing and testing the unit if a connector is used. Figure 4 is a reduced drawing of the component side of the board.

The circuit diagram shows a 5K potentiometer in the tone oscillator to adjust the frequency; this is really not necessary unless you are going to use a tone decoder in the system that requires a specific frequency. In our system, we used a fixed resistor selected to produce 1800 Hz. Also, you will note that there are no connec-

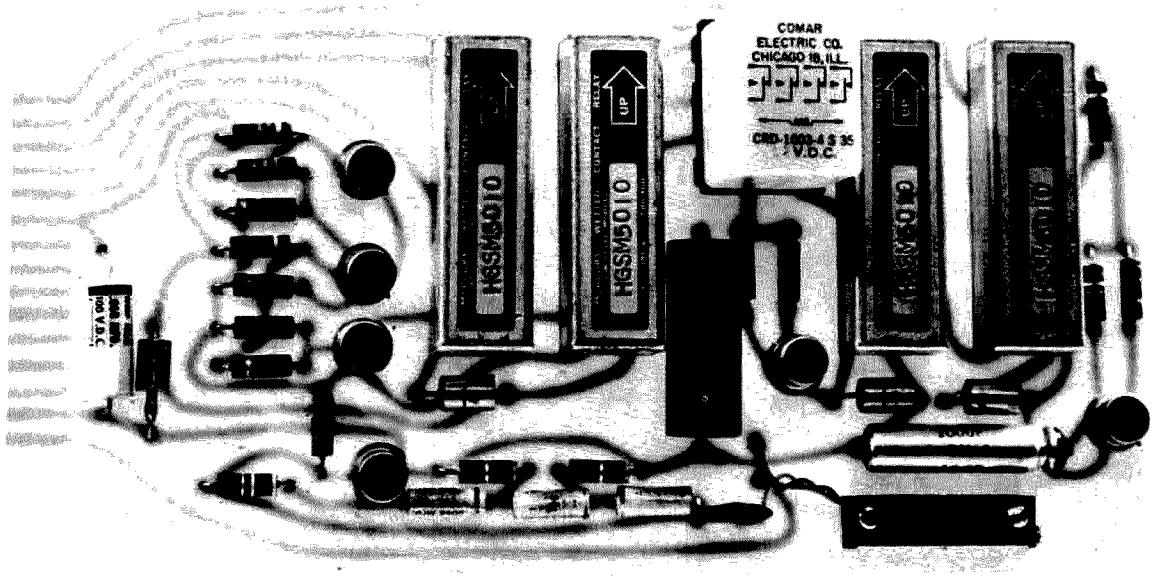


Fig. 2. A single circuit board holds all relays and other components of repeater controller.

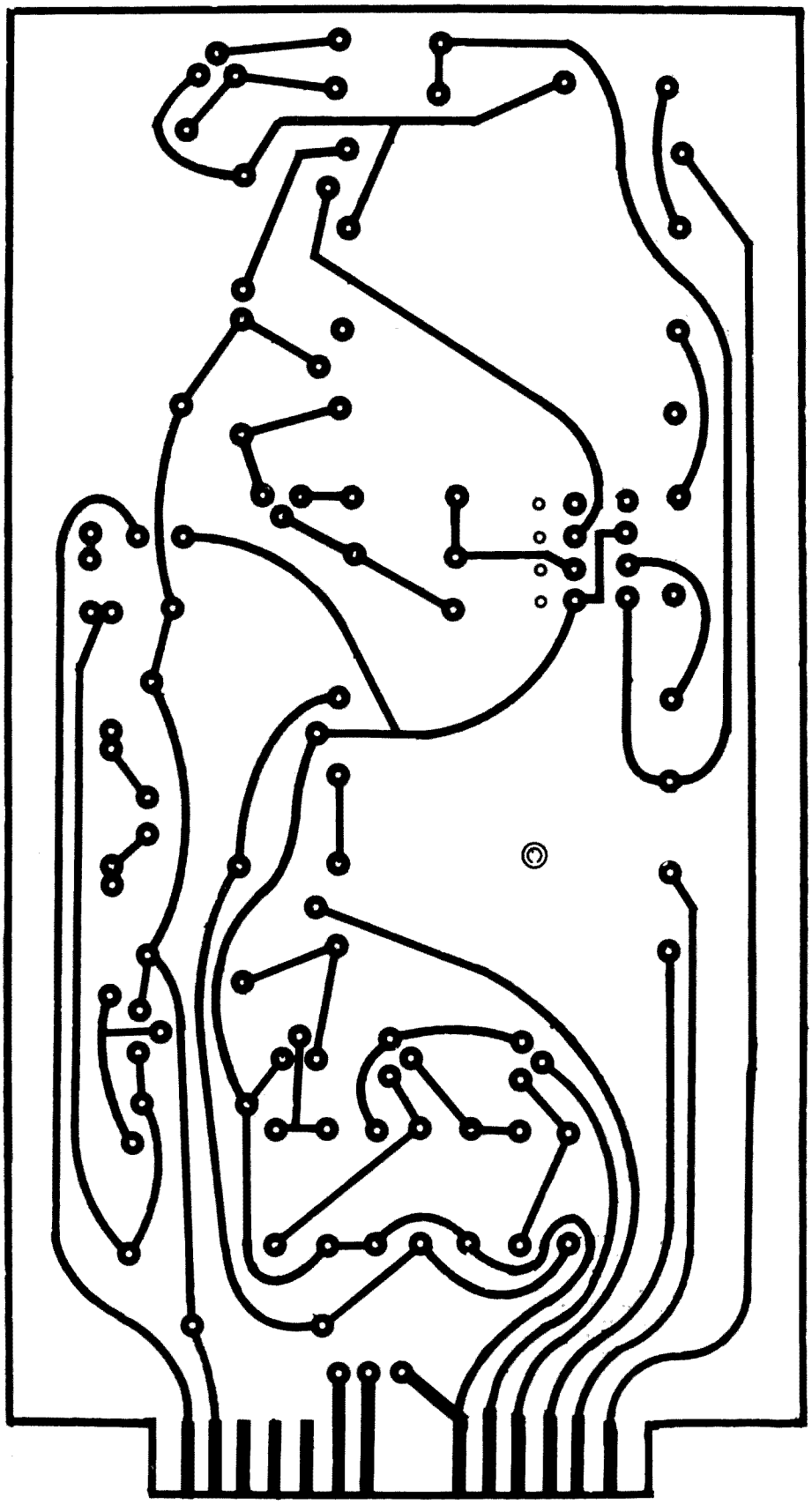


Fig. 3. Full-size layout of repeater controller printed circuit board.

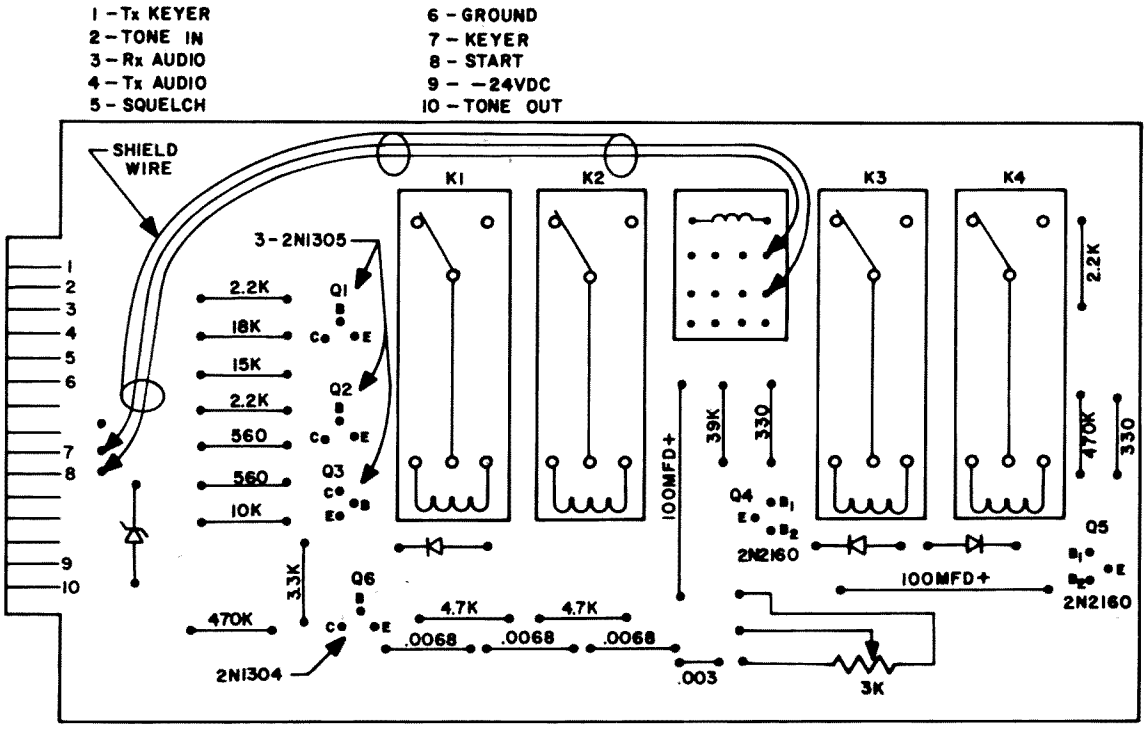


Fig. 4. Proportionately reduced sketch of board shows coding for components and wiring interconnects.

tions from section D of relay K3 to the edge of the PC board. Since this set of contacts switches commercial 115V power, we found it necessary to use a two-conductor shielded wire directly from the relay to the edge connector to eliminate hum pickup in the transmitter audio.

The controller can also be used in continuous-tone-squelch (CTS, Private Line), repeater systems where it is desired to key the repeater with the continuous tone transmitted by the mobiles, by using the circuit shown in Fig. 5. In this operation, When the reed contacts close, the 0.05 μF capacitor charges to the 24V supply, which is then applied to the base of input transistor Q1. This transistor then operates the controller and keys the transmitter. The time constant of the *RC* network is long enough to prevent the controller from following the momentary-contact closure of the reed. Since some reeds have a tendency to remain vibrating longer than others after removal of the input signal, you may wish to vary the value of the 0.05 μF capacitor as well as the input

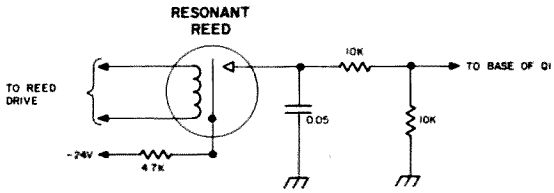


Fig. 5. PL-reed interconnections for use with continuous-tone carrier-squelch systems.

drive to the reed coil so that the repeater audio will be switched to the tone oscillator input in as short a time as possible after the tone input is removed from the reed. This will prevent receiver squelch noise from being transmitted momentarily at the end of each mobile transmission. This problem is minimized if your mobiles are equipped with a squelch-tail eliminator circuit, which provides a short burst of tone 180 degrees out of phase with the normal transmitted tone at the end of each mobile transmission, thus providing a damping action on the reed relay to stop its vibrations.

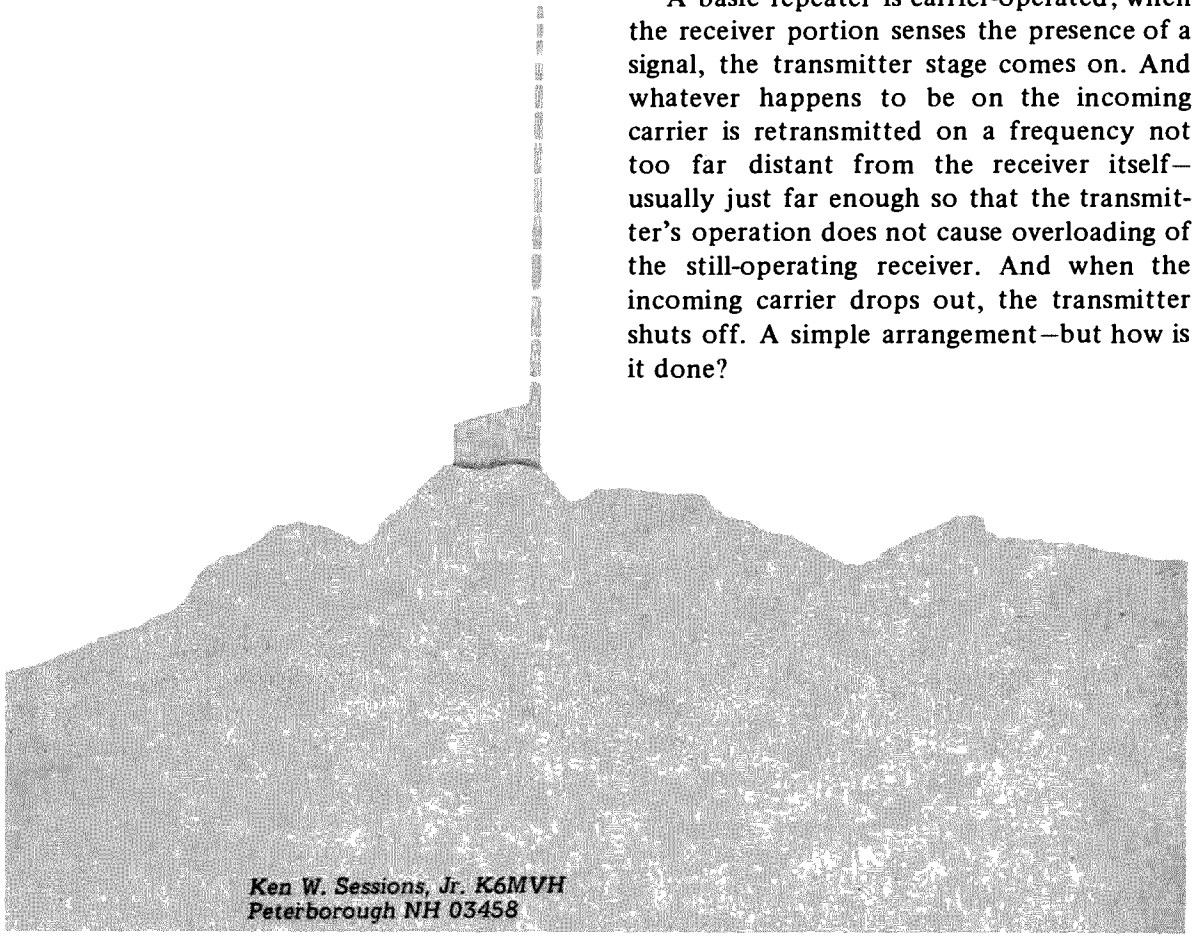
. . . WA4YND ■

UNDERSTANDING THE CARRIER-OPERATED REPEATER

The complicated repeater is not really so complex after all...it's only a matter of understanding the simple operations that are taking place when somebody transmits on the input frequency.

In spite of what the local repeater talent would have you believe, the big machine up there on the hill—or on the top floor of the city's biggest building—is really a pretty simple arrangement of gear. That is not to say that it hasn't been sophisticated, with the incorporation of perhaps a remotely controlled telephone, some sexy control devices, or maybe an automatic input-frequency switching and selection system. But strip off all the chrome and there's not much dazzle left. A repeater is something anyone can build—and without as much effort as you might think.

A basic repeater is carrier-operated; when the receiver portion senses the presence of a signal, the transmitter stage comes on. And whatever happens to be on the incoming carrier is retransmitted on a frequency not too far distant from the receiver itself—usually just far enough so that the transmitter's operation does not cause overloading of the still-operating receiver. And when the incoming carrier drops out, the transmitter shuts off. A simple arrangement—but how is it done?



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Understandably, a repeater is a bigger mystery to the devoted AM operator. His thinking is limited generally to the workings of the typical AM receiver, and he finds it difficult to see how a receiver can be easily and cheaply made to operate next to a transmitter on the same band without "blocking." He may also have trouble understanding how the transmitter of a repeater can be made to come on without fail when a signal appears, yet NOT come on when noise and garbage are present on the repeater input channel. Which brings us to the reasons why VHF repeaters are virtually always FM.

It is not within the scope of this article to get involved with AM versus FM in terms of operational performance. There are many convincing arguments for FM on that basis alone, but they are, after all, just that: arguments. The prime reasons that repeaters are made to operate in the FM mode are that FM receivers are inherently less susceptible to the normal interferences of the amateur bands and FM receivers are factory-equipped with electronic switches capable of reacting to the presence or absence of legitimate signals.

As it happens, the typical interference noises that occur on the VHF bands are amplitude-modulated. Fortunately, FM receivers are, by their nature of operation, deaf to AM signal components. FM receivers have built-in limiters that reject amplitude-modulated signals. When the AM signal is riding on a healthy carrier, the FM receiver filters out the audio completely and permits only the rf to come through. If the AM signal is weak and noisy to start with, the FM's electronic switch doesn't even believe it's a signal at all, so nothing gets through to the speaker—not even the noise.

The electronic switch is a squelch. To the wives of hams, it is perhaps the greatest invention since earplugs. The squelch on an FM receiver keeps the audio amplifier (and, thus, the speaker) shut off unless a definite signal is present. The big difference between the squelch on an FM receiver and one on an AM receiver is that the FM squelch can't be fooled by noise.

The fact that FM squelches are trick-proof makes them particularly adaptable to repeater applications. If the squelch is used to trigger the transmitter when a signal is sensed, and to turn the transmitter off when the signal goes away, the mysteries of carrier operation begin to disappear. An AM repeater operated by the squelch typically found in AM receivers would keep the repeater transmitter keyed every time the noise level at the repeater site rose a bit. And if the repeater were adjusted to compensate for the noise, half the signals on the input frequency wouldn't be capable of actuating the repeater.

This can be explained on the basis of another phenomenon: For more reasons than those already cited, weak FM signals are virtually noise-free while weak AM signals must compete with the noise. (This statement is made with the assumption that the listener is receiving on a receiver designed for the mode. Many would-be FM'ers never quite made it over from AM to FM after comparing AM signals with those of FM and deciding that, watt for watt, AM was better. But they made their judgments based on comparisons made with their AM receivers! All the noise that was there—but unhearable by the FM receivers—probably all but wiped out those "band-wasting" FM stations.)

Where repeaters are concerned, noise works to the advantage of the FM'er, even though to the detriment of the AM'er. The reason: FM squelches are noise-operated; the higher the noise level on the band, the less apt the repeater will be to get keyed on. A signal, regardless of its strength, has the peculiar characteristic of quieting the noise. And with carrier operation, when the noise goes, the repeater transmitter comes on. Since noise is always present in the absence of a signal, the transmitter of a carrier-operated repeater cannot be keyed unless a signal is present.

A typical FM squelch circuit is actually a very simple device. Its formidable appearance on a receiver schematic is attributable to the Rube Goldberg manner in which it operates. Consider the block diagram of Fig. 1, where the last four stages following the low i-f of a General Electric Progress Line FM receiver are pictured across the top. The audio-carrying low i-f signal is fed from the

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second limiter to the discriminator, which separates the af from the rf, and feeds the audio to the amplifiers and speaker. By

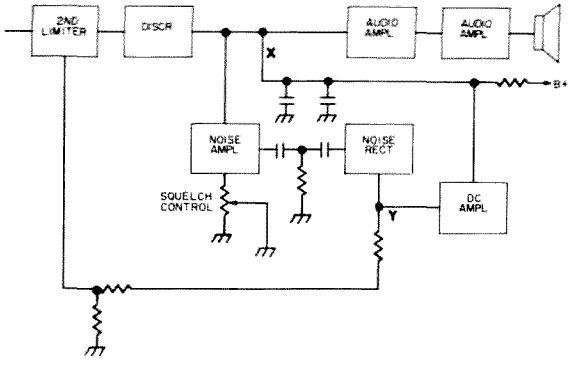


Fig. 1. Combination schematic and block diagram showing squelch arrangement in typical FM receiver.

electronically turning the audio amplifier on and off, the signal reaching the speaker can be controlled. And this is precisely the function of those elements shown below the four top blocks.

The object of the network of components in the squelch train is to provide a negative voltage at point X when no signal is present. This negative voltage keeps the audio amplifier cut off so the speaker is silenced. The B+ applied to point X through the series resistor keeps the signal biased positively unless the dc amplifier is conducting. And the dc amplifier will not conduct unless there is no signal present. Or, stated more simply, the dc amplifier does not conduct when a signal is sensed by the receiver.

The audio signal from the discriminator, as previously mentioned, always bears noise unless a signal is on hand to quiet the audio line. This noise is amplified to the extent required for effective squelch action (adjusted by the squelch control), and rectified. The positive output voltage is fed to the dc amplifier along with a negative signal from the second limiter.

The second limiter grid supplies the negative signal through critical balancing resistors. The signal here is relatively stable because the limiter operates in a state of near saturation even when no carrier is present. Since the noise rectifier supplies a positive signal, the dc amplifier sees the

balanced sum of the two supply points. An imbalance exists when the noise rectifier output increases to the point that causes the dc amplifier to conduct.

The capacitors along the X line are included in most receivers to hold the squelch open for a short time after the carrier drops out. This prevents rapid on-off fluttering of the repeater transmitter when a weak station is operating on the input frequency. The squelch "tail" can be lengthened by raising the value of these capacitors (thus increasing the charge time), and almost eliminated completely by removing them altogether.

Getting a transmitter to turn on and off in response to an incoming signal is simply a matter of applying the squelch principle to an additional stage. The carrier-operated relay schematic shown in **Fig. 2** is a modified version of the type GE used on its nontransistorized commercial repeaters, and it is perhaps the most popular single circuit in use by amateurs today.

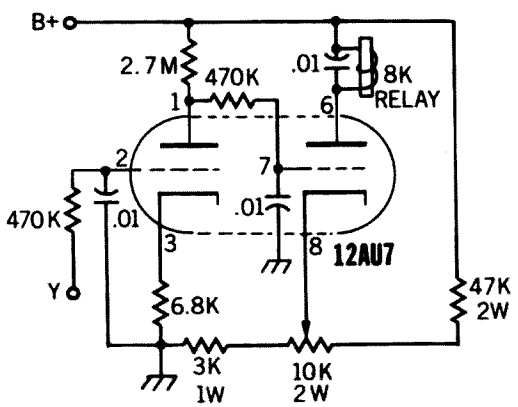


Fig. 2. Carrier operated relay.

Undoubtedly, a number of prospective repeater builders will look at the circuit and be appalled by the fact that it is not solid-state. Well, there's a good reason. Solid-state carrier-operated relays are available and easy enough to build, but the amateur world isn't quite ready for them yet. Solid-state devices require low-voltage dc; most repeaters are tube-type. And it is a lot simpler to build a tube-type relay circuit for a tube-type receiver (with its already available power supply) than it is to build a solid-state relay and be saddled with the task of building up a special power supply to drive it.

The signal input to the 12AU7 grid of **Fig. 2** is provided from the point marked Y on **Fig. 1**. The mechanical relay in the plate circuit of the second half of the tube is a current-sensitive relay with a coil resistance of 8–10 kΩ. The push-to-talk circuit of the repeater is keyed indirectly by the contacts of this relay.

The 10 kΩ pot in the cathode circuit should be rated for 2W and should be a wirewound type. This pot sets the threshold of the audio squelch.

Just one last word or two about carrier-operated repeaters: The relay shown in **Fig. 2** should never be used to perform direct switching of push-to-talk circuits. The contacts of these sensitive relays are generally quite delicate and are thus easily fouled. Regardless of a repeater's inherent simplicity, the plate relay should always be made to drive a "slave," which should be a heavy-duty type with as many contacts, both normally open and normally closed, as possible.

In one way or another, a carrier-operated relay figures into just about every automatic operation of a repeater, for active as well as passive applications. The normally closed position allows disconnection of functions during transmit, removal of voltages during control selection, and operation of timers for automatic shutdown when the repeater is unused for predetermined periods. The normally open position allows audio and push-to-talk switching, timer keying for automatic shutdown on excessively long transmissions, and initiation of functions that must occur during the presence of a carrier. To be universally applicable to any possible control function, the carrier-operated relay slave should have several sets of unused contacts in addition to contacts which provide these basic logic signals:

- Ground when signal is present on repeater input and only then.
- Control voltage available when signal is present and only then.
- Ground when no signal is present and only then.
- Control voltage available when no signal is present and only then.

. . .K6MVH ■

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EVALUATION

STANDARD SR-C-806M SOLID.STATE 2 METER NBFM 12 CHANNEL TRANSCEIVER

A short time ago I had a large assortment of antiquated surplus police and utility company wideband FM communication equipment. Suddenly all of this changed! I became the proud possessor of a Standard SR-C 806M 2 meter transceiver. But I'm getting ahead of myself.

My 2 meter FM activity was quite varied; mobile (repeater and simplex), base station, and a Handie-Talkie to take on frequent trips out of the immediate area. The investment in this hodgepodge of miscellaneous gear was no small amount. Nor would the size and appearance of the equipment win any beauty contests!

I was also motivated by the fact that I was about to take delivery on a new 1970 Buick Riviera. The available trunk space was ridiculously small. Dash mounting of a control head also presented serious space problems. Consequently, the introduction of the new line of completely solid state 2 meter FM transceivers for amateur use prompted me to close the obsolescence gap.

The clincher which guided me to the Standard was the 12 channel feature, the three levels of power available (with the external amplifier), and its small size and weight. The Standard SR-C 806M appeared to satisfy all of my requirements. There are several repeaters functioning in the San Francisco area and its environs. My trips take me to other areas that have repeaters operating on different frequencies. I also desired to operate "simplex" on 146.65 and 146.94 MHz and use "reversed" crystals on WB6AAE, the repeater operated by the club to which I belong. Reversed crystals are sometimes useful when the repeater is out of order or when a group is out in the "boonies" and out of range of the repeater. Consequently, my window shopping came to an end when Standard announced a ham version of its marine transceiver. (I had recently seen the Standard SR-C 801 SAR VHF rig developed for the new marine band, and was impressed with its small size, workmanship, and operating characteristics.)

I ordered the rig, hoping to coordinate its arrival with the new car. The car arrived a month after the rig, but this gave me the chance to try out my other objective; namely, to try the rig in several vehicles. I found that I could unpack it and its accessories from my attache case, plug the power cord into the cigar lighter socket, put the magnetic-base antenna on the car roof, complete the hookup and be on the air in less than five minutes!

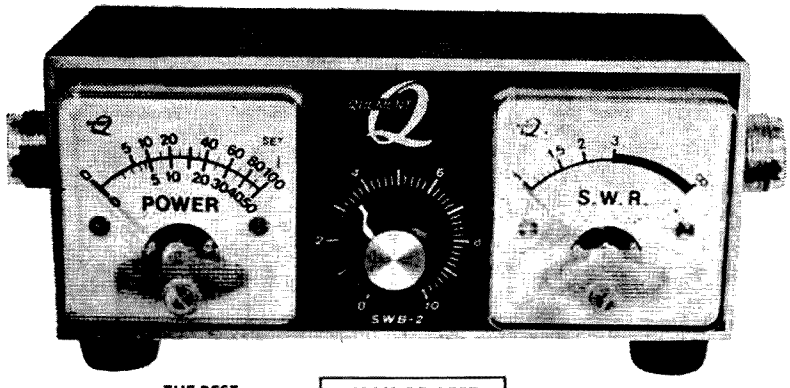
I went "whole hog" by also getting the ac power supply and the 25W rf amplifier. The rig came with a microphone and connecting cables. The price of the rig also included crystals for four channels. I also ordered crystals for the out-of-town repeaters and had jumpers put in to provide other input/output combinations without the need for additional crystals. This is easy to arrange by using the same crystal for more than one channel "pair."

The semipermanent installation in the new car took a little longer. I had forgotten that I had ordered a tape deck stereo. This precluded mounting the rig under the dash. The size of the rig is 2¼"H x 6"W x 9"D

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and weighs in at just over 4 lb. The obvious place was under the tape deck and attached to the "hump." The shop foreman where I work helped build the custom mount shown in the photo. The external power amplifier was tucked under the dash but out of the direct blast from the heater ducts. A GAM type TG-2R antenna was mounted near the leading edge of the trunk lid. The deck area immediately behind the window was not accessible because of the rear window ventilation equipment and ductwork. The encoder and tone burst control was placed in the mike line. Standard provided me with extra plug and socket which I wired into the tone box. This permits the option of plugging the mike into either the tone box or directly into the rig. A simple modification to the rig provided the optional ability of automatic tone burst whenever the transmit key is depressed. There is a fourth wire in the mike receptacle to bring the receiver audio out for the handset option. Since I do not use a handset, I used this terminal for the "switched on B+" necessary to operate the automatic tone burst.



The internal 2½ in. speaker is a square type with exceptionally good audio. I also have the 4 x 6 in. oval speaker for shack use. When the latter is plugged in, the internal speaker is muted. The small speaker has plenty of output to fill the car with easy copy.

I have had some difficulty with alternator whine getting into the transmitter

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and going out on the air along with the audio. This appears to be a function of the car being used and how hard the alternator is working. Standard is coming out with a filter to go in the supply line but I have not seen it yet.

Standard's SR-CL25 power amplifier has been very useful when operating in fringe areas. Whenever someone reports that my signal is a little "scratchy," I boost the power to the top and become full quieting. It was also interesting to see how often I could drop the power to the 800 mW output position and still be heard!

The receiver has been excellent in its operation. The published specs on this rig stated a 0.3 μV threshold sensitivity, and the results bear this out! Squelch action is also good. If I did not want to listen to the ragged edge I would tighten it a little, thereby raising the threshold, and eliminate the squelch scratch.

The operational manual has been a problem because it is written in Japanese. The phonetic characters (Katakana and Hirugana) I could translate because I was a "guest" of the emperor for three years during WW2. The Kanji or picture language was too much for my meager knowledge of their language. Standard has informed me that there will be an English translation available at about the time this article appears in print.

The control knobs are a little crowded. I have had some difficulty turning the channel selector knob because of its proximity to the mike jack. Two sets of pressure transfer numbers were provided to identify the channels. I preferred to mark the channels with the large numbers 1 through 12 rather than the very small numbers which post the frequencies in MHz. The large channel numbers can be easily seen while mobiling whereas the small frequency numbers are too small to see at arm length. A quick glance while driving is all that is needed to know what channel is being monitored. In almost no time I was able to remember which channel did what. Also, if I ever change the relative location of the crystals or add more to work other frequencies I will never have to touch the channel selector dial.

Warranty. So far it has been good. I have had some problems but that is understandable because the serial number on my rig is # 001. In fact, it was somewhat of a prototype or engineering model. After about 6 weeks of fairly rugged use the 10W power level became inoperative. It was quickly repaired by the local rep. Later on, the power selector switch developed a problem in that it would not properly shunt out the limiting resistor which was the method used to raise the power from 0.8 to 10 watts. I recommended to the factory rep that Standard install a "dump rectifier" to limit arcing at the switch contact in case power level was changed during transmissions. So far, I can say that the warranty has been backed with satisfaction.

Overall satisfaction. For my purposes the rig has come up to my expectations. With my other rigs I was unable to transmit or receive from many locations. These areas are now solid copy. For example, "Zero Microvolt Valley" just north of San Rafael, Calif. provided a challenge for my rig which was clearly conquered. A large traffic tunnel which used to be a total blackout for me now provides good two-way coverage; I can copy throughout its length and be heard by the repeater except for a few hundred feet at dead center.

This article does not take the space to list the information on the manufacturer's data sheets or specifications. These can be obtained from Standard Communications Corp. or its local representatives.

. . . W6QGN ■



5/8 wave mobile antenna for 2 meter FM

Gilbert Boelke W2EUP
505 Main Street
West Seneca NY 14224

In the Buffalo area, this antenna has held the FM mobile gain record since 1967.

A few years ago, a group of the Buffalo FM mobile enthusiasts ran some comparative tests with different types of mobile antennas. This article describes our testing procedures, gives the results, and describes an improved version of the 5/8-wave antenna.

Horizontal vs Vertical Polarization

As long as antenna polarization is matched at opposite ends of a path, there is little to choose between horizontal and vertical propagation. Although man-made noise pickup is higher on a vertically polarized receiving antenna, the inherent noise rejection afforded by FM tends to offset this disadvantage. The big advantage in going vertical for mobile operation is that antennas with substantial gain can be built with reasonable size and neat appearance. Fortunately, vertical polarization has been standardized for channelized FM communication.

Table I shows relative antenna gain, referenced against a dipole, illustrating the gain advantage. Gain figures were obtained in the literature cited in the first four references at

Table I. Relative gains of various antennas under ideal conditions. All verticals measured over a perfectly conducting ground plane.

TYPE	POLARIZATION	GAIN[1]	GAIN[2]	COMPARATIVE POWER
1/2λ dipole	horizontal	0 dB	0 dB	100W
1/4λ whip	vertical	0	0	100
1/2λ whip	vertical	+1.8	+3.6	44
5/8λ whip	vertical	+3	+6	25
3/4λ whip	vertical	-1	-2	160
Big Wheel	horizontal	0	0	100
Turnstile	horizontal	-3	-6	400
Halo	horizontal	-2 to -4	-4 to -8	250 to 630W
7/8λ phased	vertical	+4.2	+8.4	14.5W

[1] Test antenna at one end of path.
[2] Test antenna at both ends of path.

the end of this article, except for the 7/8-wave phased vertical, which was measured against a 5/8-wave antenna. Just to emphasize the effect on mobile-to-mobile operation, the fourth column in Table I shows the relative performance when both stations use the same antenna type. The last column converts the relative gain figures to power levels, indicating the power each station would need to realize the same signal-to-noise ratio for the different antennas, referenced to 100W using dipoles.

It must be recognized that there are gain variations —depending upon the shape of the car body, the position in which the antenna is mounted, and the direction of measurement. Our tests tended to verify the handbook figures except in the case of the 3/4-wave whip. Theoretically, the gain of this antenna at the horizon should be about 1 dB below a ¼-wave whip, but in the tests it proved to be almost the equal of the 5/8-wave whip. This anomaly is attributed to the fact that the car body is not really a flat infinitely conducting ground plane. It might be interesting to see how it behaves when located at the center of the roof, a test we did not conduct.

We tested 1/4–, 5/8–, and 3/4–wave whips, two phased collinears of different types, and the 7/8-wave phased antenna to be described. In the listening tests, two antennas were mounted on the same car on opposite sides or on cowl and roof, etc. A coaxial relay was used to switch between them. Testing operators would switch antennas while in motion, saying "antenna A," then switching to the other antenna, saying "antenna B" many times in rapid succession. On the average, a clear difference could be discerned between antennas, despite the fact that for each individual comparison either antenna might have shown up better.

The cars were driven in all directions relative to the receiving sites in average terrain in western New York.

Receiving stations were not told what antennas they were hearing or which was which. Even on the same pair of antennas, the letter designations were sometimes scrambled to prevent any possibility of prejudiced responses due to psychological fixation. It was most impressive to find that the reporting station operators could not find any difference between two identical antennas tested as a control.

Each antenna was carefully matched for a 1:1 swr, and the feedlines were cut to the same length, except in the roof-mounted installations. In this case 5 additional feet of RG-58/U cable were deliberately included, since the extra line is needed anyway in a practical installation. A 5 ft length of RG-58/U coax exhibits a loss of about ½ dB (depending upon age) at 147 MHz. This difference could account for the fact that the 5/8-wave antenna behaved identically on the roof and the cowl.

Table II lists the tests and the results. It was concluded that the 5/8-wave antenna offered the best performance. It is also one of the easiest antennas to build. The other

Table II. Test results (in order of decreasing effectiveness).

ANTENNA TYPES COMPARED AND MOUNTING LOCATIONS	TEST CRITERION	RESULTS
7/8λ phased on cowl vs 5/8 on same mount	Measurement	7/8λ shows 1.2 dB more gain
5/8λ on one cowl vs 5/8 other cowl	Listening test	No difference
5/8λ cowl vs 5/8 on roof	Listening test	No difference
5/8λ on one cowl vs 3/4 on other cowl	Listening test	5/8λ has slight edge
5/8λ on cowl vs 1/4 on roof	Listening test	5/8λ superior
1/4λ on roof vs 1/4 on cowl	Listening test	Roof mount superior
5/8λ on cowl vs 3 el. collinear on other cowl	Listening test	5/8λ better
3 el. collinear vs 1/4λ on roof	Listening test	Collinear better

collinears had the same performance, so only one collinear is mentioned. In one case it turned out that the power loss in the collinear partly offset its gain, since it heated up when appreciable power was applied.

The 7/8-wave phased antenna came about as an attempt to improve on the 5/8. It was reasoned that the 5/8-wave antenna was not the maximum length that could be tolerated on a car, and that making it longer must make it better, if only the current flow could be maintained in the same direction throughout its length. Current distributions are shown in Fig. 1 for a 5/8-wave, a

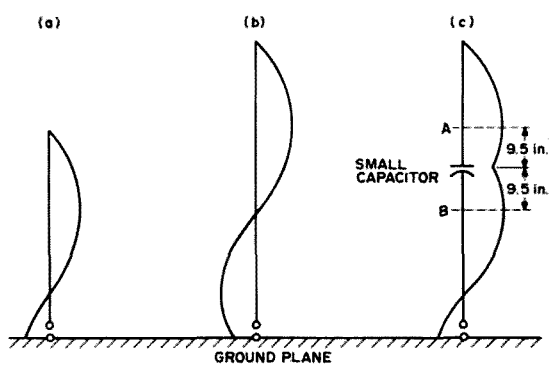


Fig. 1. Current distributions of 5/8-wave whip (a), and 7/8-wave whip (b). A series capacitance 3/8 wavelength from the top changes the current distribution as shown in (c).

continuous 7/8-wave whip, and the modified current distribution resulting from the insertion of a series capacitance at a point 3/8 wavelength from the top. The capacitor method of phasing meets the conditions of simplicity and efficiency.

An antenna of this type was constructed and adjusted to exhibit the current distribution shown. It was found that the feedpoint impedance was little changed from the standard 5/8-wave antenna. Because of this similarity, a different test method was used to evaluate it in an effort to obtain a quantitative comparison.

A 5/8-wave whip was installed in the test position on the car. The matching L section was adjusted to null out any reflected power and the power level to the antenna was adjusted to exactly 20W. Signal strength was noted on a meter at a station about 7 miles away. The 5/8-wave antenna was removed and the 7/8-wave antenna was substituted. The L network was then trimmed to null out some slight reflected power. Received signal strength was reported to be higher! Power was then reduced in small steps until the received signal strength was exactly the same as it was with the 5/8-wave antenna with 20W. The power then read 15.1W – for a difference of 1.2 dB. This procedure was repeated with the car moved to another spot. This time the power had come down to 14.8W, for a difference of 1.3 dB.

Other tests were made to determine whether the capacitance value was optimum, verifying that it was. If it is assumed that the

published value for a 5/8-wave antenna (3 dB gain) is valid, the gain of the 7/8-wave job must be at least 4 dB!

Construction

My antenna consists of a 39 in. length of ¼ in. diameter Dural rod for the base section, and a 29 in. length of 3/16 in. Dural rod as a top section. The two sections are joined with a piece of 3/8 in. diameter

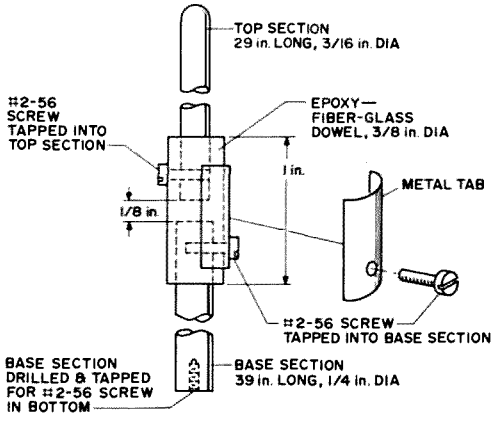


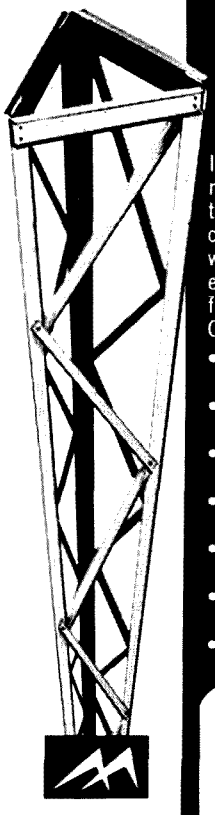
Fig. 2.

epoxy–fiberglass rod as shown in Fig. 2. A small metal tab is fastened under the screw connecting to the bottom section, and is trimmed to obtain the proper amount of capacitance between the top and bottom sections. Epoxy is used to hold the parts together rigidly and permanently.

The base mount consists of a high-voltage potentiometer-insulating fitting, made of epoxy–fiberglass with a ¼ in. shaft bushing on one end and a shaft lock on the other. Clamping the shaft lock on the base section holds the base of the antenna in place. Removal is quick and easy by loosening the shaft lock. Connection to the base section is accomplished by attaching a short Teflon-insulated wire to the end of the base section by means of a #2–56 screw tapped into the end. This wire is stripped and tinned on the bottom and a small alligator clip is used to connect into the matching network.

Impedance Matching

Due to the similarity to the 5/8-wave antenna, this antenna can be matched with a coil at the base as indicated in previous articles (Ref. 5). However, for the most accurate match, an adjustable matching network at the base of the antenna inside the



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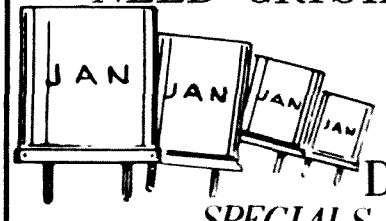
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car offers three advantages: (1) Extra selectivity is added to the antenna system, minimizing interference problems on both receive and transmit; (2) other antennas may be substituted on the same mount and brought to a match with little trouble; (3) the system can be accurately matched to 1:1 SWR.

A schematic and a sketch showing a suggested construction and mounting method are shown in Figs. 3 and 4. Each trimmer is adjusted for minimum swr alternately until an exact match is obtained. If C1 reaches minimum capacitance before a match is achieved, reduce the inductance of L1 slightly. If more than half the capacitance of C1 is used at the null point, increase L until it tunes near minimum capacitance.

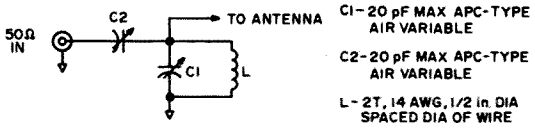


Fig. 3.

This procedure assures maximum coupling efficiency.

Adjustment of Current Distribution

Feed at least 20 or 30W of rf to the antenna, adjusting for an impedance match as outlined. Hold a neon bulb against the tip of the antenna until it fires, then slowly slide it down the top section. Exactly ¼ wave from the top (19 in.) it should go dim or

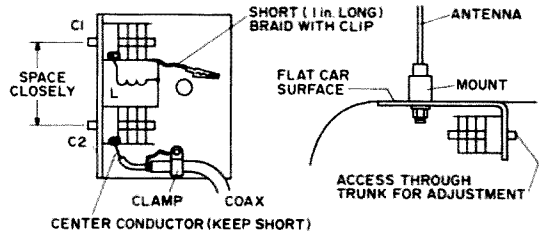


Fig. 4.

out. Continuing on down, it gets brighter at the top of the capacitor. Below the capacitor another null should be found. The position of this null moves up if the capacitance is increased, and down if it is decreased. Point B in Fig. 1c is the proper position for this null. If it is too high, reduce the capacitance in small steps by trimming the metal tab on the insulator with a pair of tin snips. As the null moves down it tends to get broader and less distinct. If doubt exists about its position, attach a paper clip to the tab to move it up to where you can see it. Then reduce



A base mount was fashioned using a high voltage potentiometer mount from an old oscilloscope.

capacitance slowly, observing the null carefully as you go. When the proper adjustment is found, epoxy the rods, the tab, and tape up the insulator.

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. . . W2EUP ■

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HOW DO HAM RADIO STORES DECIDE THEIR TRADE-IN FIGURES?

Stellar Industries gives a "from the horse's mouth" rundown on the way prices are figured in the ham business.

In a letter to the editor of this magazine published in the November 1969 issue, W4GJW suggested several topics for articles for the magazine. The subject of this article is one of those suggested. Some members of the ham fraternity seem to want to know how ham equipment dealers arrive at trade-in allowances, and as a ham equipment dealer myself, I will try to answer the questions that arise. The procedure that is followed in my organization may not be precisely the same as that followed by others, but I imagine it is fairly typical.

First of all, it is necessary that we make a few assumptions. Primary among these is that the dealer has to have a potential resale market for the item or items. Consequently, in order for this market to exist, in most cases the equipment must be in working order. Most reliable dealers recondition all the used equipment they take in, in order to insure that it is working. Occasionally, it is not worthwhile to recondition a piece of equipment. When that happens, the dealer sells it at a reduced price "as is." Naturally, if a piece of equipment has to be sold "as is" the trade-in allowance cannot be as great as when the equipment needs very little reconditioning. Of course, the cost to the dealer to do the reconditioning must be taken into account in figuring the allowance, too.

Generally speaking, a given piece of equipment to be traded in, if it is in reasonably good condition, will bring approximately the same dollar value to the customer in his allowance, no matter what

new piece of gear is purchased. However, in extreme cases, pricewise, there will be some upward or downward adjustment in the allowance. I will cite an example that, in itself, is extreme, but will serve to illustrate the point. If you have an old receiver that is worth, on the average, $75.00 on a trade-in, and you decided to trade it for a complete Collins S line, selling for around $2,000.00, the dealer would probably up the allowance to around $100.00 or more. On the other hand, if you wanted to buy a $100.00 power supply, the allowance would drop down to around $50.00. Furthermore, if all you wanted to buy was a $60.00 preamp, it wouldn't be worth your while or the dealer's to even consider a trade.

The way my firm operates in figuring trade-in allowances is to follow roughly the procedure I am going to outline. First, we determine the price we think we can sell the unit for if it is in good condition. This figure is arrived at by looking at our own prior experience with the same or similar equipment. and also making reference to the prices charged for this used equipment by other dealers. Incidentally, most of the major suppliers who advertise in 73 have a relatively current used equipment list available for the asking. Next, we try to estimate the cost of reconditioning. If this cost is extremely high (such as in the case of extremely old items with hard-to-get parts) we usually plan to resell the merchandise "as is." Third, we make an educated guess about how long the used equipment will remain on our shelves before it is sold. The longer it remains in the inventory, the less salable it becomes and storage costs are a part of our overhead, of course.

Obviously, we are in business to make money, overall. Contrary to what some customers, who consider themselves sharp traders, may feel, we don't make a bundle on ham gear – new or used. In fact, in figuring trade-ins, we calculate all the factors mentioned above, and make the allowance based on a break-even figure. Our reason for this is that we plan to make our profit on new equipment and give trade-in allowances primarily as a service to our customers. As a matter of fact, if we cut allowances to a point where we could make a reasonable profit on used gear, we wouldn't have any used gear to sell. Our customers would find it more to their advantage to sell the old equipment on their own and pay cash for the new equipment, and in some cases this is the best way for all concerned anyway.

To pin trade-ins down to a percentage figure, I would say that, on the average, our trade-in allowances would be 75 to 80 percent of the price for which we hope to resell the gear. So you see, your friendly neighborhood ham dealer is neither "out to get you," nor to lose his own shirt being nice to you; but he is merely operating under normal good business practices.

While we're on the subject, this might be a good time to say a few words about used ham gear in general. Those of you who are oldtimers in ham radio don't really need to be told much, but some of the newcomers coming along undoubtedly wonder whether to invest their hard-earned money in used equipment, or wait that much longer until they can afford the new. Many good bargains can be found if you shop around. A wide range of equipment is available from World War II vintage "boat anchors" to some of the most up-to-date sideband transceivers. Of course, some of the real old stuff won't get on SSB, but with a bit of resurgence in CW work that has come about since incentive licensing went into effect, a lot of it can be quite useful. Of course, the lower power transmitters and older receivers are excellent beginners' rigs for young Novices with limited financial resources. Probably the two cautions which should be noted most in buying used ham gear are: First, buy from a reputable dealer or individual whom you know, and second, look over the wiring carefully when considering used kit-built equipment. Other than that, the world of used ham equipment can open up all sorts of possibilities for you. In fact, some people feel the same way about used ham equipment that they or others do about used cars: Let someone else work the bugs out and get hit with the rapid depreciation for the first year or two.

. . . W2CFP ■

BERYLLIA

The Lethal Refractory

J. K. Bach WB2PAP
Ivy Hill Road
Walden NY 12586

Take another look at those tube boxes on your shelf.
Those ceramic jobs that are made with beryllia could be dynamite.

In the near future you are going to see ceramic-insulated vacuum tubes with the following notice on the carton, or on the tube, or both: "WARNING–BERYLLIA–POISON–DISCARD–SAFELY!!" What does it mean?

It means exactly what it says. The ceramic, or more properly *refractory*, is beryllium oxide, and it looks like any other ceramic: white, opaque, textured like an eggshell, not shiny, and hard enough to scratch glass. Yes, it is poisonous–*very* poisonous–but after fabrication is amply safe to use.

But children have a devilish ingenuity when it comes to smashing things, and their own reasons for doing the unthinkable. If a child or an uninformed adult got his hands on a discarded tube of this sort–! He might fracture it and cut himself on a shard of the material, thus getting particles into his blood stream. He could be in serious trouble. Or if he ingested the particles on his luncheon sandwich, say, he certainly *would* be in trouble. If any of it powdered and he inhaled even a small quantity, he very probably would die unless he got immediate medical help. The powder has the same effect on the lungs as phosgene, one of the basic war gases.

Exactly how poisonous is it? What is the exact fatal dose? Odd as it might seem, nobody knows–though it is at *least* as poisonous as arsenic, and perhaps much more so. The reason is that some people are unusually susceptible to a certain poison, while others are nearly immune to what would ordinarily be a fatal dose. Arsenic is a very good example of this–the fatal dose is given as more than so much and less that such-and-such. But peasants in Tyrol and in Syria practice arsenicophagy, which is salting food with scrapings from their chimney flues, which contain an arsenic compound deposited there by burned fuel. The practice is illegal, but they have done it for generations and will probably continue. Arsenic has been prescribed from the earliest times for skin ailments. And those Tyroleans do have beautiful clear skin! The Borgias used arsenic in their brand of politics, and it is still used in medicine. Mountain climbers take a tiny amount to increase their resistance to fatigue. And at one time a Swedish chemical plant sunk excess arsenic in the ocean to get rid of it. Sound familiar?

But beryllium is a different cat altogether. It is not used in medicine in any amount or form. It finds more uses in industry every day; airframes for high-speed aircraft, moderators for nuclear reactors, windows for X-ray tubes, as well as an alloying element for many metals, principally but not exclusively copper. This last

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we all know–2% beryllium and the copper spring never breaks. Hazard? Not after fabrication.

Beryllium is not simply an irritant–industrial safety men claim that it is a "protein poison" which in some way poisons the body cells directly. It finds its way into the bone marrow, where it affects the hemoglobin. Once in the body, it is eliminated very slowly, and it causes damage to the lymph nodes and the liver. It produces granulomas, which are grainy tumors. Convinced?

Inhalation of the dust is by far the most serious hazard; introduction by ingestion or puncture is comparatively rare. After manufacture, powdering the stuff would be fairly difficult, though children and some adults might manage it. If you think it's easy, try it on an ordinary porcelain insulator! So while the hazard is fearfully real, it is remote so long as you treat it with the same respect afforded arsenic, cyanide, or radioactive substances. I don't like radiation either, but I don't hesitate to wear a luminous-dial wristwatch. Knowledge is safety, ignorance is danger.

And speaking of ignorance–remember the warnings about the original fluorescent lamps? Did you take them seriously? I didn't! Oh, I knew that the stuff was probably irritating, but it never occurred to me that a little powdered phosphor from just one broken lamp could kill me. That phosphor was beryl zinc silicate, no longer used. After lawsuits and investigations, the maximum safe dust contamination was determined to be from one to two (that *spread* again!) *micrograms* per cubic meter! I'm sorry, but today this sounds like fresh, pure mountain air to me.

So what *is* beryllium, exactly? It is a light metal, brother to aluminum, but it melts at a much higher temperature, 1284 degrees C. It conducts electricity about a third as well as copper and is a good heat conductor. It is not ductile and is difficult to form into sheets. A billet of beryllium costs from $50 to $100 per *pound*, and if you want the 100-proof stuff it will set you back $2700 per pound. When shipped, it must by law bear a poison label. Chemical handbooks warn you not to taste even the smallest quantity of any beryllium compound to see if it is really sweet, but to just take their word for it. Chemists used to do this. The original name for the metal was glucinium, from glucose, a sugar.

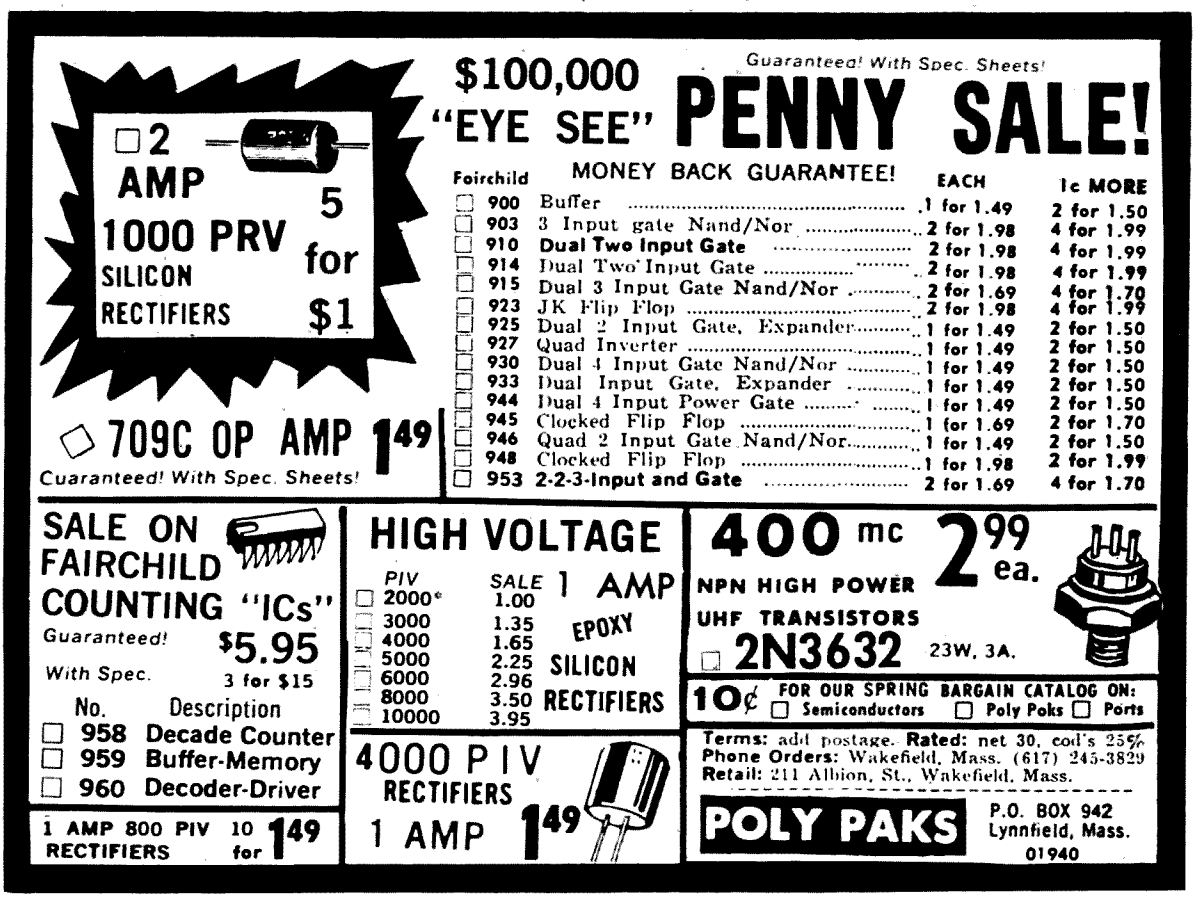
You wouldn't do anything so foolish? I hope not. Once I had a refrigerator that released a quantity of sulfur dioxide gas in my apartment–smelled like a chicken house. When I got through coughing, I moved back in and breathed residual gas absorbed by drapes, bedding and rugs. I would have done much better camping in the street–I had bowel and stomach upsets that persisted for well over a year. But I have learned from the experience. Now when a selenium rectifier stack breaks down and stinks up the place, I'm the first one out of the room. Selenium in the ground is absorbed by growing grass which is eaten by cattle which abort and breed monsters ("selenism") and poisons people who consume the meat and milk. A brother to sulfur, it's poisonous enough, but not in a class with our new friend.

So why use the damned stuff? First, it is perfectly safe if treated intelligently. The second reason is that it will make possible a new breed of high-power, high-frequency, high-performance tube.

Combine beryllium with oxygen, BeO, and the conductivity for electricity drops to zero, since there are now no unbonded electrons. But the heat conductivity which is pretty good for a metal is utterly *fantastic** for a refractory, and the melting-point is practically doubled: 2450°C. Red heat is only a little more than 1000°C. The low coefficient of expansion helps too, but the heat conductivity is the real reason that tube men are getting excited over its possibilities. They don't care how hot the refractory gets so long as the seal holds, but if the heat can be readily conducted through it (imagine!) the other electrodes will run cooler, or dissipate larger amounts of power, or both. At high frequencies where tube capacitances are a vital factor, a 'notter," smaller tube is possible.

So you use an 807 or 6146? Fine! They don't have or need beryllia. But you may

*Twenty times that of quartz, 62% that of copper, and even higher than metallic aluminum, which is only 55%. Fantastic is right!



wind up in a broadcast station which does use the new tubes, and you will then need to know how to handle them. Which is, with the same care you use with *any* tube. The stony stuff won't rub off on your hands; no amount of handling or exposure could possibly affect you. It must at all costs be kept out of your body in *any* quantity! If you handled a broken tube as if it were radioactive, that would be about it. Make sure that all the big pieces are collected. Then get up the smallest fragments—use a rag made tacky with shellac, varnish, grease, whatever will work. If the tube was really crushed, beware dust—turn up the airconditioning, or open windows and doors, and stay clear until you are sure it has dissipated. Put the fragments together with the tack-rag into a plastic bag, and make plans to return the package to the manufacturer, or to bury it in the back yard.

If you get a sliver in your skin, remove it completely, *make the wound bleed* by *gently* squeezing it to flush out any particles remaining, and consult a doctor at once. Probably you are in no danger, but why take a chance? Feeling foolish is better than feeling dead.

You have got a new tube that maybe has beryllia insulators? Send now to know which types have it; if it ain't on the carton, they will not tell thee. Appearance means nothing but heat conductivity does. Put a soldering iron on the plate and a finger on the grid ring. With glass or ceramic, you can hold it there a long time. If you have to remove the finger almost immediately, you have beryllia there. The stuff is unique—it couldn't be anything else if it is a good insulator and a good heat conductor in thick sections. If you have beryllia, treat it with respect and you will be perfectly safe.

Beryllium. Beryllia. What makes the name so familiar? Beryllium copper? Maybe, but nature makes a compound of beryllium:

$$Be_3Al_2(SiO_3)_6$$

occurring in hexagonal crystals of almost unlimited size, with various hues due to trace impurities. These are called beryl and are semiprecious stones. But if the stone is perfect, and you have just the right amount of chromium in your beryl, you have a natural emerald!

. . . WB2PAP ■

STAFF

Getting Your Extra Class License

Part XV: Spurious Radiation

Amateur radio operators operate radio transmitters.

This may sound like an obvious observation, but it implies directly that *good* amateur radio operators operate their transmitters well—and that means that they must know *how* to operate them. Consequently, the FCC examination for the Extra Class license contains a heavy proportion (1/9 of all the questions on the study list cover this subject) of items intended to test the applicant's knowledge of transmitter operation.

Because of the number of questions and the many items contained in them, we'll devote not one but two sections of this study course to the subject of transmitter operation. This time, we'll deal with the following questions from the FCC study list:

53. How can a transmitter be tested for self- oscillation? What precautions should be observed during testing?

72. What radiotelephone transmitter operating deficiencies may be indicated by a decreasing antenna rf current during modulation of the final rf amplifier?

75. What may be the cause of a decrease in antenna current during modulation of a class B rf amplifier?

77. How can parasitic oscillations be prevented?

87. How can the final amplifier of a transmitter be tested for self-oscillation?

As usual, we won't attempt to deal directly with these specific questions. Instead, we'll rephrase them into more general queries, covering the same subjects but in broader scope.

These five specific questions divide into two broad groups, one dealing with self-oscillation and other spurious signals in a transmitter and the other dealing with problems during modulation. Let's break each of these groups up into a couple of questions to aim at the major subjects.

First, let's find out "What are the causes of spurious signals?" such as self-oscillation and parasitics. Then let's ask "How can we find and fix spurious-signal problems?" That should take care of questions 53, 77, and 87 adequately.

Turning to modulation problems, let's find out "What does antenna current tell us about modulation quality?", and then move on to ask "What causes modulation problems?" Having found out the probable causes we can ask finally "How can modulation troubles be cured?"

That should be enough to take care of us for one chapter. Ready to start?

What Are The Causes of Spurious Signals? Ideally, the output of a radio transmitter should consist of only a single signal (which may be merely a carrier, one or two sidebands only, or a carrier plus sidebands). Normally, any signals in the output which are *not* an integral part of this single desired signal are called "spurious" signals.

Thus the list of possible spurious signals includes harmonics, modulation distortion products, parasitics, and off-frequency signals such as those generated by self-oscillation of one or more amplifiers in the transmitter.

Since we're going to deal with several questions concerning harmonics in the next

installment of this course, we'll leave them out right here. Similarly, we won't concern ourselves too much with buckshot, splatter, and other modulation-connected spurious signals, since we'll meet them later in this installment. The major types of spurious signals left for us to examine here, then, are those caused by parasitics, and those caused by self-oscillation.

Actually, parasitics are only a special type of self-oscillation, and the causes for both are extremely similar. The major difference between a "parasitic" oscillation and the condition usually called "self-oscillation" is that a parasitic occurs at a frequency far removed from the intended operating frequency of the transmitter, while "self-oscillation" occurs at or near the intended operating frequency.

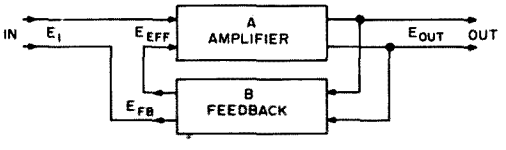


Fig. 1. Oscillation criterion depends upon both loop gain and phase shift of feedback as shown here. If quantity (1-GAINB) is equal to zero, effective gain becomes infinite and circuit will provide output with no input; this is the definition of an oscillator. Any time that this condition is satisfied, a circuit must oscillate. If it is not satisfied, oscillation is not possible.

There is, of course, only one possible cause for any kind of oscillation, if we go far enough down toward the basics of theory, and that is the fact that a closed feedback loop exists with a phase shift around the loop of zero degrees and a loop gain equal to or greater than one. This pair of conditions—unity loop gain and zero phase shift—are known as "Barkhausen's criterion" for oscillation, and unless both conditions are present oscillation cannot exist.

Unfortunately, this basic cause is so basic that it doesn't help us much in many practical instances. The feedback loop in any practical transmitter is almost always accidental; it may be due to stray magnetic coupling, to lack of shielding at some critical location (which usually does not appear to be critical for any obvious reasons), or even due to reradiation of some of an amplifier's output through power-supply leads.

If the spurious signal is near the intended operating frequency, and so falls into the category of "self-oscillation," the cause is probably directly due to an unintentional feedback path from output to some earlier stage. This feedback need not be from the actual transmitter output stage; it may be from the output of any earlier stage to that same stage's input or to any lower-level stage.

The most common causes for this type of problem are stray coupling between resonant circuits in different stages, feedback through power-supply leads, and feedback through the tubes or transistors themselves. If any stage is neutralized, misadjustment of the neutralization is always a primary suspect should self-oscillation occur.

The stray coupling between resonant circuits may be either electrostatic (which means simply inadequate shielding) or electromagnetic (improper placement). Most common in homebrew rigs is electromagnetic coupling; a commercially designed transmitter seldom suffers self-oscillation unless a neutralizing adjustment is off.

Feedback through power supply leads may occur either on the high-voltage leads because of inadequate decoupling between stages, or on filament leads by pickup and reradiation.

A less common cause of self-oscillation is existence of a "ground loop," in which the ground returns for a stage are made to several different locations on the transmitter chassis. The currents flowing between the various ground points may develop enough

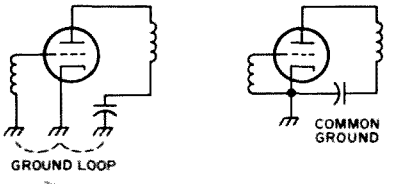


Fig. 2. Ground loop as contrasted with single-point grounding. If grid and plate currents flow exactly as shown by dotted lines at left, ground loop causes no trouble; however, if both flow through same portion of chassis, feedback may occur. For this reason single-point grounding is recommended for all construction, to prevent possibility of ground-loop occurence.

voltage to produce unwanted feedback? they may also radiate enough energy to be picked up by some lower-level stage.

Any conductor carrying a current is surrounded by a magnetic field, and so it's not possible to completely eliminate all rf feedback in any amplifier because the magnetic fields of the various conductors provide some small degree of inductive coupling between inputs and outputs.

However, proper placement of wiring can reduce this unwanted coupling to a minimum, and it's not usually a factor in self-oscillation of a well-designed transmitter or amplifier.

"Parasitic" oscillation is another case entirely. The unavoidable small coupling between conductors—both the inductive coupling we just mentioned and the equally unavoidable capacitive coupling through the air separating the conductors—means that it's always possible to get a closed feedback loop. Since the amount and type of coupling will introduce some phase shift, which will vary with frequency, it's also always possible to find some frequency at which the phase shift around this closed loop is zero. And that means that one of the two conditions required for oscillation can always be met. If anything permits the other condition to also be met, oscillation is unavoidable—and that's where parasitics come from.

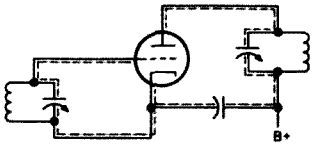


Fig. 3. This simplified schematic shows how parasitics happen. Solid lines show expected flow of signal current through entire resonant circuit. At some high frequency, though, inductors of resonant circuits act as chokes, and self-inductance of connecting leads shown in dotted lines provides a substitute for the coils so that another resonance occurs. Circuit then acts like tune-plate-tuned-grid oscillator at this higher frequency. Suppressors kill parasitics by loading down the vhf resonance while leaving the desired tuned circuits alone.

For any amplifier to produce gain, it must work into a load impedance. In general, a vacuum-tube amplifier will produce a gain which is directly related to the value of the load impedance; the higher the impedance (within limits), the greater the gain.

The designer of an rf amplifier almost always intends that the amplifier be operated at only one frequency at any given time. He designs the circuit to provide the desired load impedance at only that frequency. The amplifier stage may still have gain at other frequencies—particularly frequencies close to the operating frequency—but not as much. And at frequencies far removed from the operating frequency, the load impedance is supposed to be virtually zero, permitting no gain at all.

At the intended operating frequency, the unavoidable coupling from input to output is usually overcome by the process known as neutralization. This amounts to introduction of just enough deliberate feedback, in the opposite phase to the unwanted but inescapable stray feedback, to cancel its effects out so that the amplifier is essentially feedback-free.

A properly neutralized amplifier normally remains neutralized over approximately the same band of frequencies at which it has appreciable gain. The idea is that, for any frequency at which gain is greater than unity, the feedback be zero. If gain is less than one, the amount of feedback is immaterial insofar as the possibility of oscillation is concerned, because *both* the gain and phase conditions must be met for oscillation to occur.

Unfortunately, the intended operating frequency is usually *not* the only frequency at which an amplifier exhibits gain. While the designer may have intended for load impedance to be negligibly low at all other frequencies, the fact remains that a length of straight wire has both inductance and capacitance, and at some frequency cannot help behaving as if it were a tuned circuit.

In addition, the grid and plate structures of tubes themselves also have enough L and C to act as tuned circuits at some frequency, and the designer's carefully planned output tank circuit may exhibit resonances at more than the single frequency he intended.

At any frequency for which the impedance of these unintentional tuned circuits is sufficiently large, the amplifier will in consequence have greater than unity gain. If a zero phase shift also exists at this

frequency in the unavoidable feedback loops, oscillation must result.

We call such oscillations "parasitic" because they are like parasites; they were never planned into the scheme of things, and they can exist only when the amplifier is operating in an otherwise normal fashion.

Frequently, a parasitic may not appear when an amplifier is being tested under moderate-power conditions with a steady signal, but will blossom forth in all its obnoxiousness when full power and modulation are applied. The change in amplifier operating conditions increases gain just enough (or possibly modifies the coupling slightly) to permit the oscillation. A variation of this behavior is the type of parasitic which exists only for a few dozen cycles at the peak of each cycle of intended-frequency signal, and is absent at all other times.

In almost all cases, the cause of the parasitic is an unsuspected load impedance in the amplifier's output stage which permits amplification at unintended frequencies. Normally, the frequency of a parasitic is much higher than that at which the amplifier is intended to operate. Amplifiers intended for the 3-30 MHz range usually have VHF parasitics, VHF amplifiers exhibit UHF parasitics, and so forth.

This rule does not always hold true. In some cases, parasitics may occur at frequencies far *below* the intended operating range. The phenomenon, known as "motorboating" in af amplifiers, is typical of a lower-than-operating-frequency parasitic. It occurs when the feedback loop encompasses the entire chain of amplifiers and includes substantial time delays. This type of parasitic in rf amplifiers, occurs only rarely. When it does, the feedback path and undesired load impedance producing the unwanted gain are usually to be found in either the power supply or the power wiring, rather than in the signal circuits of any individual stage—and when these conditions exist, self-oscillation is much more likely than is a lower-frequency parasitic.

Another type of spurious signal which afflicts only radiotelephone transmitters is that produced by rf feedback into the audio circuits. This can produce symptoms very like those of parasitics. What happens is that some of the modulated rf output of the transmitter is finding its way back into the audio circuits of the modulator or preceding audio stage, and is there being detected to produce an audio signal which is a feedback signal. The feedback loop is closed by a path through the modulation process, and so both the audio and the rf signals are affected.

In addition to the fact that their radiation is illegal because of the uncontrolled interference which they cause, these spurious signals are to be avoided at all times because they can easily result in severe damage to the transmitter. Parasitics, in particular, can lead to amazingly high levels of reactive volt-amperes in even moderate-power transmitters, because the signals which are generated are predominantly confined to the transmitter (they are coupled to the antenna only by accident). The multi-kilovolt levels which result can pop coupling capacitors, melt down polystyrene coil spacers, and even vaporize tube elements by forcing the tube to improper operating points.

How Can We Find And Fix Spurious-Signal Problems? Now that we've looked at the causes of spurious-signal problems, it's time to look a little deeper and discover how to find and fix them. While there's always one easy way to find out that you have a spurious-signal problem, it's not recommended—for one thing, FCC pink slips are most upsetting to the tranquility of most of us, and while you're waiting for one to come along you may be clobbering untold QSOs or possibly even emergency traffic!

So it's best to check out any new transmitter, whether it's a homebrew rig or a store-bought outfit, to be certain that it's free of spurious signals, before ever putting it on the air.

While the checkout is a virtual necessity in the case of homebrew and kit-built equipment, it's also most important in the installation of completely factory-wired gear as well. Bad design or construction is *not* the sole reason for spurious signals, as we have seen. Misadjustment can also cause them, and even the most reputable rig *can* be misadjusted between the factory pre-shipment inspection and its arrival on your operating desk!

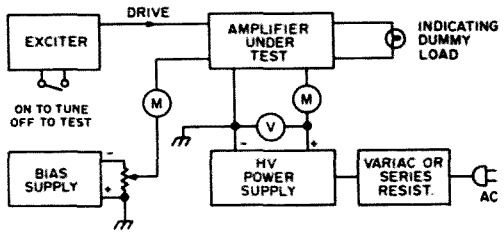


Fig. 4. This test setup can be used to test an amplifier for both self-oscillation and parasitics. Exciter is used only to provide drive while initially tuning amplifier under test. Output should disappear when exciter is switched off, and remain absent for all settings of amplifier controls. Any output indicates spurious signals; their cause should be traced out and eliminated.

The procedure in testing for self-oscillation is relatively simple. Connect the transmitter to a dummy load, preferably with some type of power indicator (a light bulb coupled to the load will suffice if nothing more exotic is available). Remove any drive by removing the crystal (don't use a vfo for the checkout). Fire up the rig, but keep plate voltage off until everything is warmed up.

Now apply plate voltage briefly and swing each tuning capacitor across its range while plate voltage is ON. You have to be fast, if the rig doesn't include fixed protective bias, to avoid tube damage due to the lack of grid bias. Any output indication at all must come from self-oscillation, since the normal oscillator stage has been disabled by removal of the crystal.

If the transmitter has many stages, it may be necessary to perform this test on only one stage at a time in order to limit the power-on time. The main thing to watch out for is permitting excessive plate current to flow for more than a very few seconds. Some of the more modern screen-grid power tubes can completely melt out their screens in less than 30 seconds under zero-bias operation!

To be absolutely safe, it's best to provide normal operating bias for each stage. This bias can be supplied from one or more small transformer-operated power supplies, adjusted to provide the desired dc output and connected to the grid of each stage through rf chokes for isolation. If this is done, keep in mind that the added grid-bias leads may, in themselves, introduce feedback unless you're extremely careful. However, with all stages properly biased, you can leave power on long enough to test all settings of the adjustments. Also, a change in bias conditions may permit oscillation during the test which would not occur during normal operation.

A quick indication of self-oscillation is the capability of tuning to a dip in final plate current at two points in the tuning range which are *not* harmonically related. Of course, if you're operating at 3.6 MHz and tune the final to 7.2 MHz you can get a dip, and this does not indicate self-oscillation. But if you get a normal dip at 3.6 MHz and, without changing frequency of the oscillator, tune a little higher to the neighborhood of 5 MHz and find another dip, this is a pretty fair indication that you have self-oscillation around either 2.5 or 5 MHz. Should this happen to you, be sure to run the full self-oscillation checkout.

Having discovered a case of self-oscillation, how do we fix it? The first step is to determine which stage in the transmitter is oscillating. If it's convenient to remove plate and screen voltage from individual stages, this is the easiest way to find out. Start at the next-to-final stage and remove both plate and screen voltage. If the oscillation is still there, it must be in the final stage alone.

If the oscillation disappears, restore power to the driver stage and remove power from the stage preceding. Reappearance of the oscillation indicates that no stage ahead of the driver is involved. To find out whether it's the combination of driver and final, or merely the driver alone, remove power from the final and couple some sort of rf indicator to the driver's output. If both stages are involved, the oscillation will disappear. If it persists, the trouble is in the driver stage only.

If the oscillations fail to reappear when power is applied to the driver, move back another stage toward the oscillator and repeat this procedure. Keep going until the trouble has been isolated to a single stage or group of stages.

CAUTION—Never remove plate voltage from a tetrode or pentode tube without also removing screen voltage. Otherwise the tube

is almost certain to be destroyed by excessive screen dissipation.

When the stage or stages have been isolated, apply the things we've already learned about the causes of self-oscillation. Look particularly for coupling between input and output circuits, and for misadjustment of any neutralization components. Also check all bypass capacitors to be certain that they're doing their job. In severe cases, it may be necessary to virtually redesign the offending stage to eliminate coupling from input to output by relocating components.

After each correction is made, repeat the test procedure to determine whether the spurious oscillation has been eliminated.

Detection and elimination of parasitics is a much more bothersome business. Most circuit designers prefer to simply assume that parasitics will be present unless they are suppressed, and design in parasitic suppressors to do away with them.

A parasitic suppressor consists, essentially, of an additional tuned circuit broadly resonant at the frequency of the anticipated parasitic, and swamped down with a composition resistor of low value to kill any effective load impedance. For tubes in the 100-watt power output class, a .47-ohm 2-watt resistor with 3 or 4 turns of wire wrapped around it does the job normally. This suppressor is connected in the plate circuit, as close as possible to the tube's plate terminal (that is, one lead of the resistor is soldered to the plate-cap clip with as short a lead as physically practical, just as bypass capacitors are installed). For higher power levels, the same idea works but higher power ratings are needed.

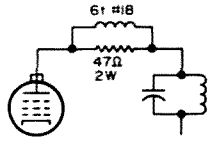


Fig. 5. Typical parasitic suppressor consists of 6 turns of number 18 wire spaced out to occupy the full length of a 47-ohm 2-watt composition resistor. This suppressor is adequate for hf rigs up to the single 6146-807-6DQ5 class; for higher power rigs, use several resistors in parallel to provide higher power capabilities. For vhf rigs, reduce coil size to 3 or 4 turns, again spaced out to full length of resistor.

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The parasitic suppressor works by concentrating any stray inductance or capacitance which might form a parasitic's load impedance into a known location, and then loading that impedance down with such a low-valued resistor that its Q is far less than unity.

If, despite parasitic suppressors, you suspect that parasitics are present in a rig, perform the same test as for self-oscillation except that normal drive signal can be applied. Output at any except the oscillator frequency or a harmonic of it can be attributed to parasitics.

Probing with a neon tube can help locate parasitics, also, if (as they usually are) they happen to be VHF or UHF oscillations.

The glow of a neon tube excited by rf pickup through its glass walls is normally orange, just as is a normal neon glow. The signals produced by parasitics, however, usually make the neon glow purple rather than orange. The change in color is not due to the frequency, but to the amount of power picked up. The neon will pick up more power from a VHF or UHF signal than it will from one of lower frequency, because it is of fixed physical size and the pickup is governed by the tube's size in relation to the signal wavelength. With excessive power applied, the neon glows purple rather than orange.

Another handy guide to parasitics, surprisingly enough, is standard equipment for most operators—a pair of ears! When a parasitic is running wild in a transmitter, it frequently causes a high-pitched whining sound. It's the same phenomenon that makes a transformer with a loose core lamination "buzz" when power is applied; in the case of the parasitic, anything which may be capable of being vibrated by it is—not at the rf frequency, but at some audio subharmonic of the parasitic's actual frequency. Occasionally, too, the power unleashed by the parasitic will cause arc-over of a tuning capacitor, and this too can be heard (and seen).

If parasitics occur in a rig which has supposedly been parasitic-suppressed, suspect failure of the suppressors first. If they are all good (check by replacement), then check for presence of ground loops and especially for common impedance in both the grid and plate circuits. A few inches of hookup wire is sufficient common impedance to develop a quite respectable UHF parasitic. And in the attempt to find and fix parasitics, keep always in mind that patience is the most important parameter!

What Does Antenna Current Tell Us About Modulation Quality? While many experts will tell you—and we won't disagree—that the only way to get a really good measure of modulation quality is to use an oscilloscope and either a trapezoid (for AM) or bow-tie (for sideband) display, the fact remains that antenna current alone, as measured by either an rf ammeter, a sampling device such as an swr meter, or even a lamp bulb coupled to the transmission line, can tell quite a bit about modulation. At the very least, it can indicate the presence of some troubles which may not be so apparent in the final-amplifier plate-current readings.

The reason that the antenna current is an indicator of modulation quality is simple. Almost any kind of modulation except for FM will result in a variation of the power applied to the antenna. Since antenna impedance is relatively constant, at any one operating frequency, the only way in which the power can vary is for the voltage and current in the feedline to vary.

With normal, high-level, 100-percent AM, and a sine-wave modulating signal, the output power *with* modulation should be 1-1/2 times as great as that *without* modulation. Since the power varies as the square of the current, to obtain this 150% power variation the current must vary about 122%. That is, the power as indicated on an rf ammeter should increase by 22 percent when 100-percent sine-wave AM is applied to the signal.

Note that this figure is true only for one special case of modulation. If modulation percentage is less than 100 percent, the current increase will be less. If some process other than high-level modulation is used, the current increase may be less (although it should not be more). And if the modulation is a voice signal rather than a sine wave, anything can happen and usually does!

Because of the great variations possible when the test signal is anything other than a

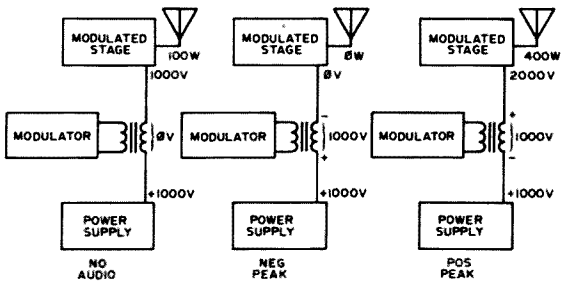


Fig. 6. Principles of high-level AM are shown here. At left, with no modulating signal, modulator output is zero volts and full voltage of power supply goes to modulated stage, providing normal output level. At center, on negative peak for 100-percent modulation, modulator output exactly cancels out power supply voltage. Modulated stage gets zero volts and output momentarily drops to zero. At right, on positive peak of signal, modulator output adds to power supply level to double voltage to amplifier and produce four-time power level. Failure to meet these conditions means modulation trouble is present.

sine wave, virtually all discussion of the effects of antenna current in modulation assumes that only sine-wave modulation is used. This turns out to be most confusing to most of us, when we attempt to put it into practice to monitor our modulation, and that's one of the reasons that the experts recommend scope monitoring—it's one of the very few forms of modulation monitoring which is equally effective on both voice and sine-wave signals.

But if we do have a sine-wave signal, as we would have if we were attempting to check out a modulator by measuring antenna current, then we can confidently look for that 22-percent increase in power when the modulation is applied.

Should the power remain constant, or decrease, it indicates something is not going right in either the modulator or the modulated stage. One possible cause of lack of power variation (constant power) might be a power-supply deficiency which reduced carrier power whenever the modulator was supplying any power. This would, of course, cause distortion by making the modulation percentage vary widely through the course of a single audio cycle.

A decrease in power or antenna current when modulation is applied, on the other hand, indicates a misadjustment of the modulated stage. Most high-level modulation schemes operate by varying the supply voltage available to the modulated amplifier. When the supply voltage is raised, the modulated stage is supposed to deliver the additional power. If its drive is insufficient, or if it is operating at the wrong point on its grid-bias curve, the additional power may not be available to be delivered. In this case, the increased supply voltage causes an actual decrease in power.

Either insufficient or excessive loading on the modulated stage, also, can cause a wrong-way power variation. We'll look at the possible causes of modulation troubles in more detail a little later; right now, the point is that failure to obtain the expected increase in antenna current does indicate problems, and may give you an idea as to the approximate type of problem which exists.

So far, we've discussed only high-level AM amplifiers. Similar reasoning applies in the case of linear amplifiers, whether they be Class A, Class AB, or Class B. When modulation is present, the antenna current readings should increase. The increase should never exceed about 22 percent from the carrier-only readings, however, with sine-wave modulation (voice may provide readings as great as twice the carrier level, in certain circumstances).

Screen-modulated stages, and those using other forms of "efficiency modulation," should also give the same normal readings. These types of modulated amplifiers, however, often exaggerate the "problem" indications of the antenna-current measurement. That is, any problem which would cause a slight decrease in antenna current with high-level modulation may cause an extreme drop in antenna current with an efficiency-modulated stage. The difference is not due to any difference in the measurement; rather, it's because these types of modulation are so much more sensitive to the particular types of problems which show up most readily in an antenna-current measurement. The degree of misadjustment which would be only negligibly off in a high-level stage may easily be intolerably out, in an efficiency modulated rig.

While the antenna current measurement can pinpoint several kinds of trouble and their probable causes, it is totally useless in

attempting to troubleshoot many other kinds of problems. For instance, antenna current cannot reveal directly the presence of distortion, nor spurious outputs such as parasitics occuring only in the presence of modulation. Neither can measurement of antenna current reveal much about sideband suppression. To spot these troubles, the scope offers the only quick way (careful probling with a selective receiver, used as a spectrum analyzer as we discussed in the previous installment, can also spot such troubles, but is much more tedious).

It's for this very reason that the measurement of antenna current has given way to scope monitoring of output, for many hams. But since the antenna current measurement *can* tell us much, and *is* one of the classic means of locating some types of modulation problems, the FCC requires that candidates for the Extra Class license know something about it. After all, a little history and tradition is just as necessary as is a knowledge of the latest state-of-the-art techniques and theories.

Now that we've seen what the antenna-current measurement can tell us about modulation quality, and what it can't, let's move on to determine the major causes of the modulation problems which our tests may reveal.

What Causes Modulation Problems? "Modulation problems" is a label covering a multitude of symptoms. In the first place, we have three distinct major types of modulation (amplitude, frequency-phase, and pulse), and a number of sub-classes within each of these types. What turns out to be a problem for one particular sub-class of one type may be desired operation for some other variety.

To illustrate this point in a bit more depth, let's look at several quick examples. If the signal's apparent center (or carrier) frequency changes when modulation is applied, is this a problem? With AM, it's a serious problem—so serious that it falls into the class of prohibited emissions! But if you're using FM, it's the desired result.

Another case: The "carrier" power level increases when modulation is applied. We're not talking about the "extra" power supplied by the modulator; we're assuming that the measurement devices are sufficiently selective to pick out only the carrier component of the output signal, and this component alone increases in strength with modulation. Is it a problem? For high-level AM it is, and we call it "carrier shift." Its presence indicates that the operating point of the modulated stage is being shifted by application of modulation, and distortion of the output signal is likely. But if we're using a controlled-carrier modulation technique, which is a common design for screen-modulation systems, then the increase of carrier power with modulation is again the desired operation.

So what is a modulation problem? Basically, it's anything connected with the production of a modulated rf signal that produces results other than those you intended to achieve.

That's such a wide field that it would take several volumes to answer our original question in complete detail for all cases. You would also get much more information than you probably will ever want about modulation problems. So for the purposes of this question, we're only going to talk about the common problems of the common types of modulation—primarily high-level AM, since we've looked at FM and sideband in other installments of this course.

To know when we have a problem, we must first find out what results we intend to achieve when we attempt to apply high-level AM to an rf signal. Several concepts for describing the amplitude modulation process exist, and all have their uses. We can look on the process as a mixing action which translates a voice signal into the rf range, or as a control action in which the voice signal modifies the gain of an amplifier to produce a signal of constant frequency but varying strength. While the first is closer to what actually goes on, the second is often useful in examining modulation problems.

If we look on the desired output signal as being a single rf signal which varies in strength (assuming 100-percent modulation with a sine wave) from zero to double the carrier-only voltage levels, we know immediately that the modulated amplifier must be capable of putting out a voltage level at least

twice that produced in normal operation without a modulating signal.

In order to do this, the amplifier must have adequate drive available to generate the double-voltage output with no change in driving signal, and it must be working into an impedance level which will permit it to develop the double-strength output. If either of these conditions is not met, we will have a modulation problem because the output cannot do what it is expected to do.

With the most conventional form of high-level modulation, the modulating audio signal is placed in series with the dc supply to the modulated stage. If the audio signal exactly cancels out the dc supply on its negative-going peak, this will take care of reducing the output signal level to zero at that time because without plate and screen voltage, an amplifier cannot produce output.

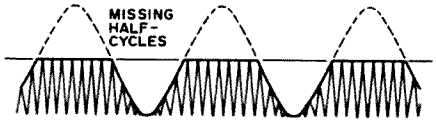
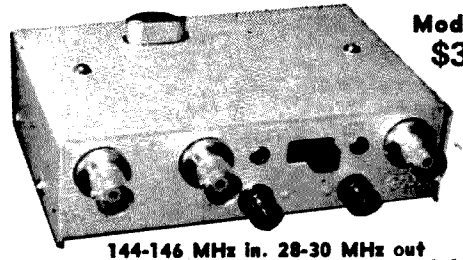


Fig. 7. If modulated stage is unable for any reason to increase its output level above that for no-modulation case, result is output waveform shown here. Negative-going half-cycles of audio signal are modulated nicely, but positive-going half-cycles are missing. This problem shows up as "downward modulation" or decrease in antenna current when modulation is applied. It causes severe distortion, but often such signals show no apparent distortion when received because action of receivers restores missing half-cycles.

But to produce the desired results, the modulated stage must produce double the normal output voltage on the positive-going peaks. The supply power is effectively doubled at this time, because the audio power from the modulator is aiding rather than bucking the dc from the power supply. If the operating point of the modulated stage is held constant, though, the doubled supply voltage cannot result in doubled output voltage—because the efficiency of the amplifier will vary with the change in supply voltage.

To avoid this problem, most modulated amplifiers are made to be self-adjusting by use of grid-leak bias. As the voltage supplied the tube goes up, the bias will shift slightly,

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and the amplifier's efficiency will remain approximately constant. The result will be the desired doubled output voltage.

The zero-to-double swing we've been talking about is, of course, in terms of peak-to-peak values. A properly modulated rf amplifier looks to the modulator like a resistive load, so when the voltage goes up the current goes up in the same ratio. Doubled voltage and doubled current would indicate four times the power—which is absolutely right, except that the four-time figure is for instantaneous peak input power. Since rms values are only 0.707 times as great as peak values, and 0.3535 times as great as peak-to-peak values, the rms power of the modulated signal is only 1.5 times as large as that of the unmodulated carrier.

Now what are some of the common problems with high-level AM? One of the most frequent is that known as "downward modulation," in which the antenna current or output power decreases rather than increasing with application of modulation. "Carrier shift" is another. Simultaneous AM and FM is a rather common complaint at vhf and uhf, and is not unknown at lower frequencies. And "mushy" or distorted modulation seems, at times, to be the rule rather than the exception—but it's a problem too. Let's look for the causes of each of these.

The basic cause for downward modulation is simple enough. Something in the modulated stage is not right, so that when the modulator changes the supply voltage the amplifier does not respond by increasing its output. In many cases, a scope examination of the output signal reveals that it is modulated only by the negative-going half-cycles of the audio, and that the positive-going portions of the audio signal are having no effect. Since we are getting the less-than-carrier-level parts of the modulation okay, but are failing to get the greater-than-carrier-level parts to make up for them, the net result is a decrease in output power.

Strangely enough, such a signal may be perfectly readable, and often has only slight distortion. Regardless, this is still a problem, and should be cured.

The cause can be anything which prevents the modulated stage's output from going up. It may be insufficient grid drive, so that there's just nothing left from which to supply more output. It may be a poorly chosen operating point (more likely too much grid bias rather than not enough, or too little screen voltage) for the modulated stage, so that the tube is simply saturated before it can reach the double-output condition. And it may be improper adjustment of the tuning and loading controls, so that the tube is not working into a proper impedance to permit it to develop the increased output power. In this case, the problem is more likely to be under-loading under carrier conditions, rather than being loaded too heavily.

Carrier shift is deliberately introduced into TV signals to indicate brightness information, but for normal audio and high-level AM it's a problem. The effect is that of having a dc component in the modulating signal. That is, the carrier level when modulation is present is higher than when modulation is absent. The normal cause of carrier shift is simply overmodulation, which does introduce a dc component by rectification of the excess modulator power. A less common reason for this problem would be poor design of the modulated stage, so that the changes in operating point which accompany modulation would drastically change the stage's performance.

Carrier shift is introduced into "controlled carrier" systems, and is in fact the carrier control which gives such systems their name. The normal manner of introducing the shift is to control screen voltage on the modulated stage with a signal obtained from the rectified *envelope* of the modulating signal rather than with the modulating signal itself. When the modulating signal is weak or absent, screen voltage becomes low, reducing carrier level. This action reduces the dissipation in the modulated stage during no-modulation periods, and permits smaller tubes to be used than would otherwise be the case. It is seldom used with high-level modulation; the most common use of controlled-carrier techniques is with screen modulation, where the power level is limited primarily by tube dissipation and anything which reduces dissipation permits higher output power from the same tubes.

Simultaneous AM and FM is a problem in any type of system, because it's prohibited by FCC regulations. While a delicate adjustment of modulation percentages can produce single sideband (with carrier) from simultaneous AM and FM, in all other cases the presence of both types of modulation at the same time simply results in excessive use of spectrum space and often results in signals which cannot be copied on any kind of receiver.

Since frequency is controlled exclusively by the oscillator, while amplitude is controlled only by the final stage or stages in high-level AM, the only possible cause of FM and AM at the same time is for the modulating signal to be getting back to the oscillator to change its frequency. This can happen if the oscillator's supply voltages are taken from a power supply which also supplies the final, the modulator, or any part of the speech amplifier, and are not sufficiently well regulated, and this is in fact the most frequent cause of this problem.

Running a close second for the title of most-frequent-cause is inadequate isolation between the oscillator and the modulated stage, so that the varying load imposed by the modulated stage under modulation reflects back into the oscillator circuit and changes its frequency. The problem has been traced to this cause in vhf transmitters through as many as five isolating stages; it usually won't occur with that much isolation between oscillator and modulated stage, but it can.

A final cause for simultaneous AM and FM might be rf feedback from the transmitter output to the oscillator. This would be indistinguishable, in practice, from reflected loading, but would succumb to different cures (which we'll examine a little later).

Mushy modulation, or distortion, is a problem which can have many causes. Overmodulation is a frequent cause. Probably the most common reason for modulation distortion, though, is what is known as "nonlinear modulation." It's essentially the same problem we already met in connection with downward modulation, but in a less severe form. The modulated stage is unable to supply the double-voltage output level, but does supply some power increase. When it gets as far as it can, it gives up. This flattens out the positive peaks of the modulated signal, which introduces severe distortion.

Non-linear modulation has many causes. One of the easiest to understand, if not to do something about, is brought about by the use of fixed bias on the modulated stage. If the bias is held constant, and enough drive is supplied to permit full upward modulation, then grid current will be excessive. The reason for this is that a large driving voltage is required to produce full upward modulation, but at the lower supply voltages present when the modulating signal falls to carrier level or even below (the modulation "trough"), this large driving voltage produces a large flow of grid current. At the peaks, when the high voltage is needed, much of it goes on through the stage and less grid current flows.

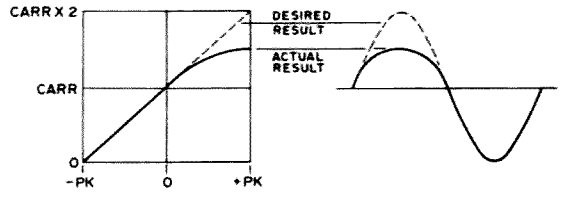


Fig. 8. If output power of modulated stage is able to increase some during positive half-cycles, but not as much as it should, the result is "non-linear modulation" as shown here. Dotted lines show the desired operation, while solid lines show what happens if modulated stage output power is limited to a maximum of 2 times carrier level rather than the necessary 4-time increase. Waveform of modulation signal is significantly distorted. This problem may be cured by increasing drive or loading, but sometimes requires redesign of the modulated stage.

Unfortunately, the grid current under these conditions is so great that tube damage can easily occur. If, then, the drive is reduced to obtain a grid-current reading within reasonable limits, there's not enough drive to supply the peaks.

It's for this reason that most high-level modulated stages are designed to use a small value of fixed or "protective" bias, and obtain most of their operating bias voltage from grid-leak bias. Together with this, the driver stage is deliberately designed to have very poor output-voltage regulation. That is, its output voltage is designed to drop off whenever much current is drawn.

Under these conditions, at modulation peaks the driver supplies full voltage because the modulated stage draws very little current from it. As the modulation cycle moves on to carrier level, the driver is required to supply more current. It can do so only by pulling down its voltage output. The grid-leak bias increases bias on the modulated stage as grid current increases, requiring a higher voltage. The result is that the driver is always struggling to supply the required drive power, and just barely succeeding in doing so. Average grid current, as indicated on a meter, remains moderate, but actual drive levels are great enough to provide linear modulation.

If, however, the driver is adjusted to supply too little drive power, full upward modulation still cannot occur. Similarly, if the modulated stage output circuits are improperly adjusted, the full upward modulation power levels cannot be achieved in the antenna.

Improper design of the modulator itself can also be a source of distortion. Unless the modulator can supply the required output power levels distortion-free, it's a waste of time trying to trouble-shoot the total system. Possible causes of distortion in the modulator include an improper impedance ratio for the modulation transformer, improper grid bias on the modulator itself, or improper performance of the audio driver stages ahead of the modulator.

Locating the source of distortion in a radiotelephone transmitter is a job which virtually requires a scope. First, the modulator must be checked out to assure that it is capable of delivering the power. Then the modulated stage must be checked, and finally the complete system.

Lacking a scope, however, it is still possible to determine the modulation capability of the transmitter. To do so, we start by assuming that the modulator can deliver at least a small part of its audio essentially distortion-free, and apply a very low percentage of modulation to the carrier. We then use our receiver as a spectrum analyzer, looking for side frequencies at twice, three times, four times, and other higher harmonics, the frequency of the modulating tone removed from the carrier. If all is working properly, these side frequencies should be absent.

Next, we crank up the audio gain of the modulator until large amounts of distortion are present, as indicated by downward modulation of the antenna current or flicker of the final-stage milliammeter, and again look for the second-harmonic side frequency. This time, it should be easily detectible.

Finally, leaving the receiver set on the side frequency, we reduce the percentage of modulation until the side-frequency signal disappears. We then search for other harmonics; if the transmitter is working properly, all other side-frequency harmonics should be absent when the second-harmonic side frequency disappears. All we need do now is to determine the percentage of modulation being applied, and that's the maximum modulation capability of this transmitter.

If other side frequencies are present, distortion within the modulator audio stages is indicated. Non-linear modulation normally causes second-harmonic distortion to appear in the envelope before any higher-order distortion products show up, while intermodulation in the audio stages more often results in third- or fifth-order distortion products.

To measure the modulation percentage, when the modulating signal is a sine wave, we can use a peak-to-peak indicating ac voltmeter connected across the modulation transformer secondard (DANGER—high voltage, be sure all power is off before connecting the meter!) and compare the peak-to-peak ac reading thus obtained with the dc voltage applied to the modulated stage. For 100 percent modulation, the p-p ac reading should be exactly double the dc value. For 50 percent modulation, the two readings will be equal. To get the percentage for any two readings, multiply the p-p ac reading by 50 and divide the result by the dc reading; the result will be the modulation percentage, directly.

How Can Modulation Troubles Be Cured? We've met a number of modulation problems and their causes, now. The logical final question for this installment is how to cure them.

In almost all cases, a cure can be effected simply by removing the cause of the trouble. This may, however, in the case of some forms of distortion, amount to a complete redesign and rebuilding of the modulator. Let's concentrate on some of the simpler troubles for a start, and leave redesign of the equipment until some other time.

To cure the troubles evidenced by downward modulation of antenna current, or by downward fluctuation of the final plate current meter, try first increasing drive to the modulated stage (unless it is already running with maximum rated drive). Increasing the grid bias on the modulated stage may help also, especially if drive is already at maximum. Next, check the coupling of modulated stage to antenna or other load. Increase loading as necessary to remove the trouble. Ideally, a modulated stage should be loaded to the point that the plate-current dip is barely perceptible—unless this overloads the tubes, in which case bias should be increased and screen voltage decreased as necessary to keep plate current within reasonable limits while maintaining the loading heavy.

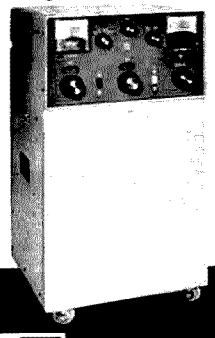
Be certain that the dc plate voltage to the modulated stage does not exceed ratings for the tubes involved; if it does, reduce it to the rated limit and see if the trouble persists. Also, check the final tubes for weak cathodes, which can cause this problem.

Insufficient modulation of the screen-grid along with the plate can cause this trouble; increasing the percentage of modulation to the screen is the normal cure. If screen voltage is taken from the plate supply via a dropping resistor, this cure normally is not applicable.

Finally, the output filter capacitors in the power supplies feeding either the modulated stage, the modulator itself, or both, may be too small, resulting in poor voltage regulation and a consequent inability to supply the necessary power peaks. Increasing the value of these capacitors is always a good idea; they can hardly be too large. If electrolytic capacitors are used (relatively common in the 100-watt class of rigs), they may have aged so that actual value is much less than the marked value. Such capacitors should be replaced.

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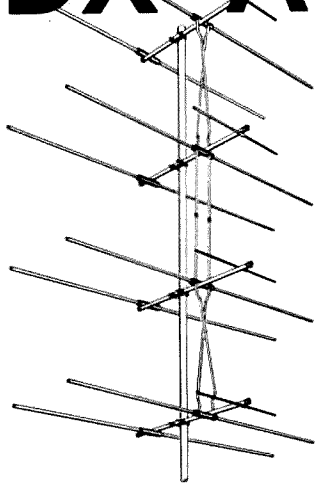
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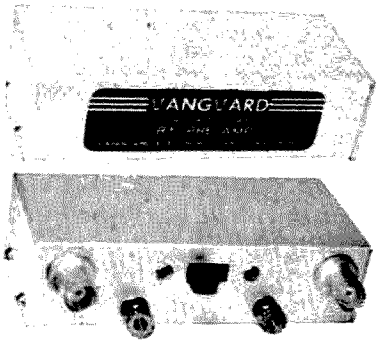
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The preceding suggested cures apply to plate-modulated AM transmitters. In addition to most of the above, the following are also applicable to any type of grid-modulated AM rig:

Too much rf drive can cause downward modulation, just as can too little. With grid modulation, the drive level is critical and must be adjusted carefully to obtain optimum results.

Too light loading; this is much more critical with grid modulation than with plate modulation. Grid-modulated transmitters should be loaded so heavily that the resonance dip is not perceptible at all. When modulation is absent, the tube will be dissipating maximum power. Application of modulation then increases efficiency of the modulated stage to produce the additional output power required.

If the plate-current needle flickers upward when modulation is applied, any of several problems may be present. The problems and their cures are:

Overmodulation—cure this by turning down the audio gain or speaking more softly. This is applicable to any type of modulation.

Incompletely neutralized modulated state—cure by neutralizing the stage more completely.

Parasitics in the modulated stage—eliminate the parasitics.

When screen modulation is used, screen voltage too low—cure by increasing screen voltage.

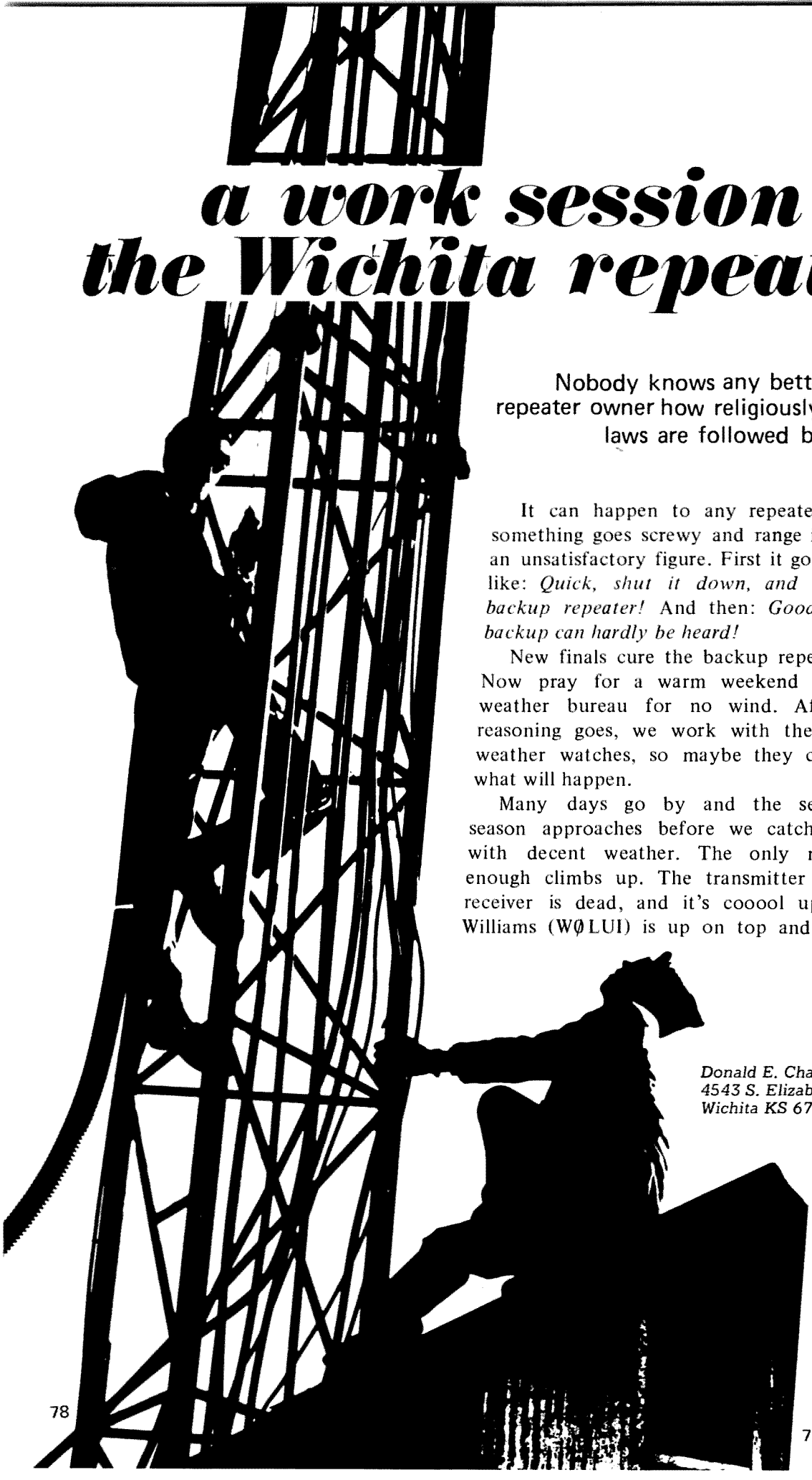
When control-grid or suppressor modulation is employed, too much grid bias—reduce grid bias.

While all these problems and cures depend largely on the indications obtained by antenna current measurement or by observation of the final-stage plate meter, a steady plate meter or upward-modulating antenna current does not necessarily indicate good modulation. It's quite easy to get a set of conditions in which one kind of distortion on positive half-cycles of audio balances out an opposite kind on negative half-cycles, so that the current measurements look good but the modulation is really mudulation. The scope provides the only certain check on this. However, for any specific rig, the scope is necessary only once; after initial adjustment, the plate-current or antenna-current measurements can be used to spot minor departures from desired operating conditions.

Next Time. We're only halfway through our examination of transmitter operating techniques. In the next installment, we'll be looking at the problems of control of harmonics and of coupling transmitters to the antenna system, among other things.

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Nobody knows any better than the repeater owner how religiously Murphy's laws are followed by Nature...

It can happen to any repeater – suddenly something goes screwy and range is reduced to an unsatisfactory figure. First it goes something like: *Quick, shut it down, and turn on the backup repeater!* And then: *Good Grief! The backup can hardly be heard!*

New finals cure the backup repeater trouble. Now pray for a warm weekend and ask the weather bureau for no wind. After all, our reasoning goes, we work with them on severe weather watches, so maybe they can influence what will happen.

Many days go by and the severe-weather season approaches before we catch a weekend with decent weather. The only man healthy enough climbs up. The transmitter is dead, the receiver is dead, and it's cooool up there. Jay Williams (WØLUI) is up on top and the 6-meter

Donald E. Chase WØDKU
4543 S. Elizabeth
Wichita KS 67217

repeater is okay, but – Wow! The 2-meter machine needs much fixing before it can go back on the air.

New tubes are sent up via the hoisting cable, but before long the bad news is discovered: A 6-inch piece of wire works better than the receiving antenna. The equipment is in working condition, but an antenna replacement is necessary.



One thousand feet of eighth-inch aircraft cable is permanently mounted to the tower. This picture shows Don Patterson (KØKN), left, and Glen Brasch (WØHYR) as they start a load up to the top. The building on the right houses the 10 kW output of KEYN-FM and microwave remote control equipment. The building on the left houses two low-band and two high-band quarter-kilowatts, two low-band and remote control stations, and two 450 MHz mobile relay stations. Also inside is the Wichita repeater identification equipment and terminal equipment for the telephone

We can't replace it today, but this is the second time in three and a half years of repeater operation we have lost an antenna. A pair of decisions are made. First, the replacement antenna will be side-mounted some 6 feet *below* the top of the tower. Let someone else be the lightning rod. Second, if possible, obtain enough low-loss feed line to bring the equipment down to the ground.

A few days go by. On friday, the weather bureau advises that Saturday will be calm, warm, an ideal day for tower work. Grab a side mount kit and a replacement antenna, and check who is available. Pushover Chase is the fall guy, as the other tower workers have to work Saturday. Don Pryor (WAØIPB) and Vic Thomas (WAØYBM) are available for ground work.



There is no substitute for having the needed part in case of trouble. This is a complete operating SPARE repeater, ready to go, in case any or all major assemblies need to be replaced. If the man on top wants any part, any portion can be hoisted up on the cable. This site, by the way, is the location of the Wichita repeater, 6400 North Hillside in Wichita. In addition to a commercial FM broadcast station, several commercial two-way radio users are on the tower along with the Wichita 2- and 6-meter amateur radio equipment. The amateurs have a 12-pair Neoprene-jacketed messenger cable running from the top to the bottom of the tower. This is used to control various functions, such as interconnecting two repeaters, carrying 600Ω audio down for monitoring, etc. When we told the local telephone once we wanted the termination for the phone line up on top, they informed us they would be happy to do it as long as they could keep one foot on solid ground. We agreed to a termination inside the building, and the local hams obtained and installed the line from ground level to the top.

All meet and have a quick cup of coffee before heading out to the tower site. It's slow work when only one man is on top but the new (well, *almost* new) antenna is checked out on the ground with vswr meters and sent up the cable.

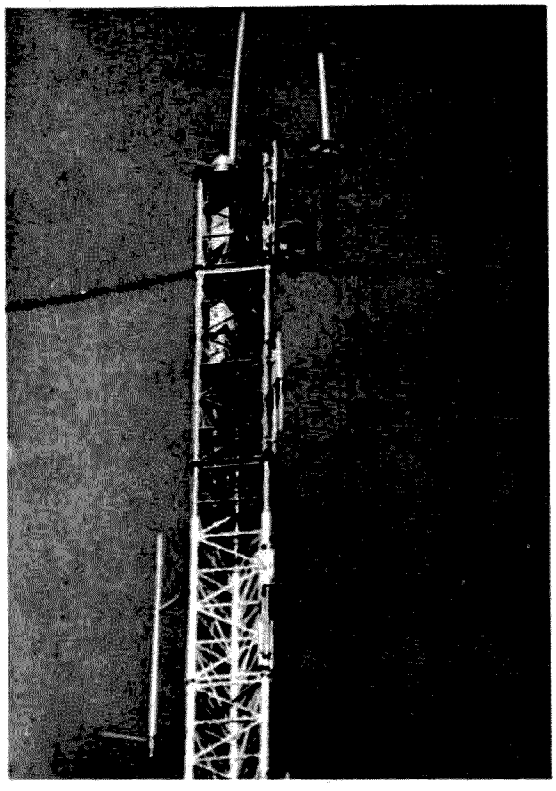
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Jay Williams (WØLUI) starting work on top of the tower. The brace he is standing on is 440 feet off of the ground. He has just opened the 2-meter repeater cabinet, getting ready to replace the final tubes. The antenna fastened to the brace he is standing on is a 450 MHz business rig. The upper left antenna (looks like it sticks out of the beacon light) is the receiving antenna for the repeater. At the lower left, the transmitting antenna is a few feet out from the tower. The antennas for the 6-meter repeater are not visible; they are side-mount types, mounted on the far leg. Several 450 MHz log periodic beams are also mounted on the far leg.

The first decision is implemented by side-mounting. The cable from the old antenna shows signs of moisture. Fifteen feet of replacement cable and all is well.

Or is it? Program material from KEYN-FM is suddenly showing up on the repeater. Careful checks of all shields, grounds, and antenna positions show that the clearance between receiving and transmitting antennas is only about 8 feet. A quick mental review of system calculations comes up with a recommended minimum separation of 20 feet. Some work with the muscles, aided by wrenches and a quantity of words (none of them the type allowed on the air) and the bottom of the transmitting antenna is now at the 380-foot level, and the receiving antenna starts at the 428-foot level.

It's getting cool, so all is given a final check, the repeater is buttoned up, and the tower jockey starts down. This takes a little while, as my muscles are tired, and I'm not quite as young as I pretend to be. But Don Pryor awaits with a cup of coffee poured and ready. As we leave the tower we enjoy the fruits of our labor. We talk to one of the hams in Mulhall, Oklahoma, one in Enid, Oklahoma, one in Hesston, Kansas, and one in Kingman, Kansas. All is truly well, the tall tower is back in service and we'll see if the weatherman is good next weekend. We now have 800 feet of foam feedline.

Now if the weatherman will give us another good weekend . . .

. . . WØDKU ■

Paul Franson WA7KRE
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Scottsdale AZ 85251

Inexpensive New Semiconductors For The Ham

A whole flock of new semiconductors that should interest the ham have recently appeared. They include both discrete devices and integrated circuits; this article will discuss the discrete types other than rf power transistors.

While it's obvious that no manufacturer of semiconductors makes any devices designed just for the amateur, transistors and other parts made for other uses are often perfect for his projects. High performance combined with low prices provide the proper combination for the builder.

All of the products described here have been introduced recently. All are manufactured by Motorola, the world's largest producer, and as such, are readily available from the wide network of Motorola distributors including Allied and Newark. The approximate single-quantity prices are listed. For more information on any device, consult the Motorola Semiconductor Data Book or write for a copy of the individual data sheet: Technical Information Center, Motorola Semiconductor Products Inc., Box 20924, Phoenix AZ 85036.

The schematics are taken from the Motorola Application Note listed. They are available from the same source.



Dual-Gate MOSFETs TO-72

A real boon to the rf designer is the dual-gate MOSFET, unmatched for low

noise, high gain, low cross modulation, and resistance to overloading in VHF and HF amplifiers. The MFE3006 ($1.50) features 25 dB typical gain at 100 MHz; it's also ideal for lower frequencies. The MFE3007 ($1.62) features 21 dB gain, 3 dB noise figure at 200 MHz. The MFE3008 ($1.29) is similar, but specified for mixer use. All have exceedingly low feedback capacitance (0.02 pF typical), so don't have to be neutralized in normal applications. Incidentally, these MOSFETs, like all made by Motorola, feature silicon nitride passivation and are not superdelicate like most other MOSFETs.

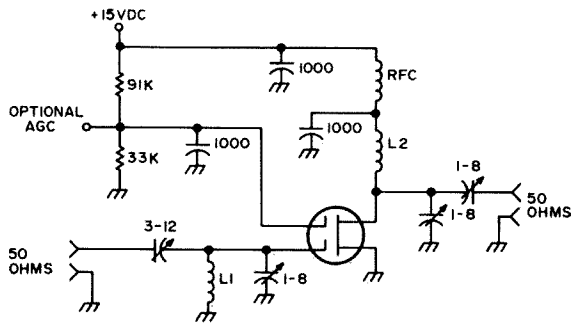


Fig. 1. Typical VHF amplifiers using MFE3007 dual-gate MOSFET. Taken from Motorola Application Note AN-478.

Typical 100 and 200 MHz amplifiers are shown in **Fig. 1** (TO-72 case).

Cheapies but Goodies

A new approach to inexpensive transistors is found in the NPN MPSA10 (29¢), NPN MPSA20 (33¢), and PNP MPSA70 (38¢). Instead of being falloffs from more expensive types, these new transistors are prime devices designed to be inexpensive. They use small dice, simple processes, and are specified to have optimum yield. All of these contribute to the low cost.

The three transistors are ideal for all general audio and low rf applications. They have BV_{CEO} of 40V, h_{FE} of 40 to 400, C_{ob} of 4 pF maximum and minimum f_T of 50 MHz (MPSA10) or 125 MHz (MPSA20, MPSA70). The data sheets are very complete for such inexpensive parts (TO-92 case).

For even lower prices, the transistors are offered in kits containing three, five, or nine transistors of a type with various h_{FE} selections. For instance, the MPSK12 costs $2.07 and contains nine MPSA10s: the cost per device is only 23¢.

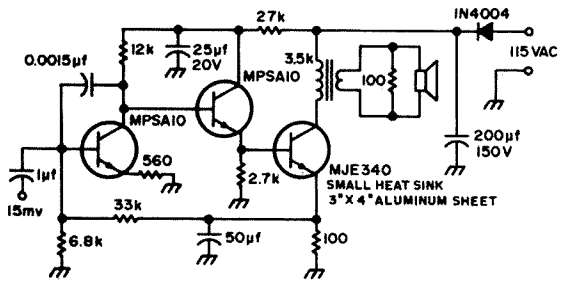


Fig. 2. 2½W line-operated amplifier. Motorola Application Note AN-426A.

A typical application is shown in **Fig. 2**, a line-operated 2.5W amplifier using a "solid-state 50L6," the 300V MJE340 silicon power transistor ($1.06).

Darlington Amplifiers

New plastic Darlington-connected amplifying transistors offer exceptionally high gains in single packages at low prices: MPSA66 (PNP, at 63¢, 75000 minimum h_{FE}), MPSA12 (NPN, 67¢, 20000 h_{FE}), MPSA13 (NPN, 47¢, 5000 h_{FE}) in TO-92 case. A 2W amplifier using an MPSA12 as a preamplifier is shown in **Fig. 3**.

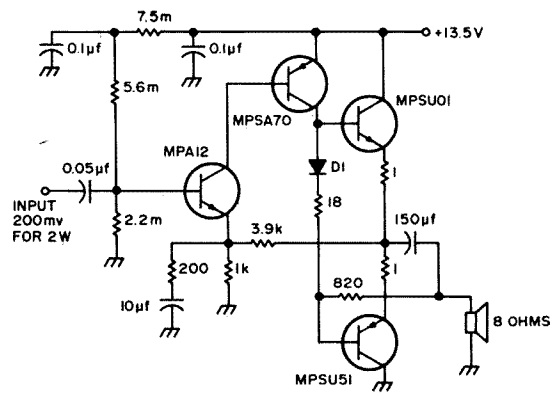


Fig. 3. 2W Audio amplifier. Motorola Application Note AN-426A.

UHF Oscillator

A new plastic transistor, the MPSH10, is designed for use as a UHF and VHF oscillator in TV sets. It's also excellent for ham use as a free-running or crystal oscillator. The MPSH11 has high f_T (650 MHz minimum), complete Y-parameter specs, and costs only 49¢ (TO-92 case).

Uniwatt Transistors

A new case for intermediate-power transistors is the Uniwatt plastic package (case

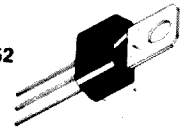
152). It is similar in construction to small-signal plastic transistors, but is larger and the metal tab on which the transistor chip is mounted is extended out of the plastic. The tab can be mounted on a heatsink for dissipation of up to 8W (the value depends on the specific transistor). The Uniwatt package was developed for use in consumer equipment such as complementary audio amplifiers and video drivers, so the transistors using it are inexpensive.

A useful complementary pair of Uniwatts are the NPN MPSU01 ($1.15) and PNP MPSU51 ($1.33), suitable for audio amplifiers with up to 5W of output.

A useful general-purpose Uniwatt is the NPN MPSU02 (99¢), similar in characteristics to the popular metal-cased 2N2219. It has a BV_{CEO} of 40V, h_{FE} of 50, typical C_{ob} of 2 pF, and a minimum f_T of 150 MHz (typically 400 MHz). Though it's designed for general-purpose use such as audio, it has been found useful for many rf applications as well.

Information on mounting and heatsinking Uniwatts is found in Motorola's application note AN-472.

High-Voltage Drivers and Amplifiers 152



Three new high-voltage transistors are excellent for use as Nixie or neon-tube drivers, scope tube drivers, or general-purpose high-voltage applications. The NPN MPSL01 (59¢, 120V BV_{CEO}) and PNP MPSL51 (61¢, 100V BV_{CEO}) are small, TO-92 case transistors with gains over 40, f_T over 60 MHz, and C_{ob} of 8 pF maximum. They have very complete data sheets.

The MPSU10 is a Uniwatt transistor (case 152) with a 300V breakdown rating, dissipation of up to 5W, h_{FE} of 40 minimum at 10 mA, f_T of 60 MHz minimum, and a C_{cb} of 3 pF maximum. And it costs only $1.50.

Power Transistors

The most popular silicon power transistor is the NPN 2N3055, a metal-cased device that costs about $2.05. A new plastic version, MJE3055, has similar specifications, yet cost only $1.41. And a PNP complement is also available (MJE2955, $2.90). Both have V_{CEO} of 60V, h_{FE} of 20 to 70 at 4A, power dissipation of 90W and f_T of 2 MHz minimum (case 90). The MJE3055 is ideal for general amplifying and switching use.



The Cheapest Transistors TO-92

The bottom of the price list is occupied by the 2N5223 at 21¢. While it does not feature great specs, it is satisfactory for many general-purpose applications: BV_{CEO} = 20V, P_D = 310 mW, h_{FE} = 50 to 800 and f_T = 150 MHz minimum (TO-92 case). The MPS5172 has the same price.



Voltage-Variable Capacitance Diodes 182

Voltage-variable capacitance diodes (varactors) are very useful in FM modulators, test equipment, afc, low-level frequency multipliers and RTTY frequency shift. Four new varactors cost only 53¢ apiece: MV2201 (6.8 pF), MV2203 (10 pF), MV2205 (15 pF) and MV2207 (33 pF). They have Q up to 300 and tuning ratios of about 2 at voltages of 1 and 10. Similar varactors with better even specs and capacitances up to 100 pF (MV2101 through MV2115) cost only 90¢ (case 182).

Thyristors 90



Four new silicon controlled rectifiers—MCR407-1 (30V, 82¢), MCR407-2 (60V, 97¢), MCR407-3 (100V, $1.05) and MCR407-4 (200V, $1.20)—are 4A thyristors with small turn-on requirements (case 90).

High Voltage Rectifiers

59

High-voltage silicon rectifiers have been relatively expensive in the past, making it necessary to use many devices in series in most practical applications. A new family of rectifiers offers PIV up to 5000V at relatively low prices. Examples are the MR990A rated a 1 kV and costing only 35¢; and the MR996A, 5 kV and $1.35. All are rated at 250 mA forward current and are in small plastic packages (case 59).

. . . WA7KRE ■

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5 Chestnut Court
Saint Peters MO 63376

RENOVATING SURPLUS METERS

A test or two, and maybe just a dab of opaque white paint . . . and presto!

Even today, many years after World War II and the Korean conflict, the surplus market is flooded with meters of all shapes, sizes, and ranges. Many are calibrated in *pps*, *QXR/2*, or *squitter*. This terminology means something to someone but doesn't mean much to you when you want to read plate current. Some surplus dealers have been kind enough to include the actual scale in their advertising, while others let you take a chance of getting something truly useful for your money.

In either case, several steps are necessary to convert the scale to understandable terminology. When your bargain arrives, arrange a test setup to determine exactly what you have. Probably the easiest way to find the full-scale calibration is a series circuit as in Fig. 1. The series resistance is adjusted to

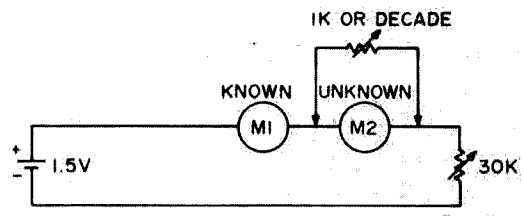


Fig. 1. Check the internal resistance of the meter by adding a variable parallel resistance across the unknown meter. Removal of the resistance gives an indication of meter sensitivity.

a full-scale indication on the tested meter and the value is read on the known meter. This is the sensitivity. A resistance decade or pot is then added in parallel with the meter and adjusted to half-scale indication. The value of the parallel resistance is equal to the internal resistance of the meter. Both the sensitivity and internal resistance should be scribed on the case for future reference. Obviously, it would be in the best interest of

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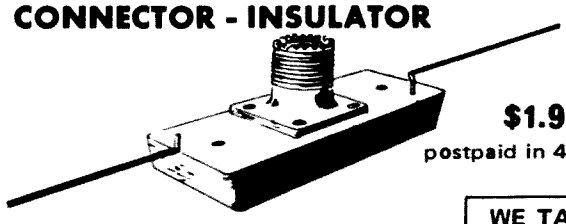


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both meters to start with a high series resistance and a high known meter scale.

Once you know what you have you are in a much better position to put it to use. The meter must now be disassembled; commonly, this is done by removing three screws around the rear circumference of the body or two screws on the back. The holes may have been sealed, in which case the sealing compound must first be removed. Slide the movement onto a clean, white, lint-free surface. Immediately check for the presence of an internal shunt or multiplier which may have caused false readings during the earlier tests. If a shunt is found, remove it. A multiplier should be shorted. In either case, recheck as previously described.

It is a relatively simple matter to change the scale. It may be as simple as marking out the legend with typing correction fluid. The existing scale can often be used by removing the old numbering as above and re-marking with decals or transfers either of the standard type or ones made especially for meters. For any work more elaborate than removing a legend it would be best to carefully remove the scale. This is normally accomplished by removing two small screws, one on each side of the scale and usually in line with the meter pivots. Use only a jeweler's screwdriver and exercise caution to slide the scale out without touching the needle or hairspring.

Perhaps your meter has only "good–bad" markings and no calibrations. All is not lost. After the scale has been removed, paint the scale area with a good coat of flat white paint and allow to dry thoroughly. Measure the length of the needle excursion using either the old scale or the needle itself. Cut and apply a new set of graduations from the variety included in the meter and panel marking transfer set available from dealers for *Letraset* transfers. Add whatever legend and calibrations you need and carefully reassemble. The cost of the transfers is rather high for conversion of only one meter but when several are to be done the cost per unit is quite reasonable.

. . . WAØABI ■

A Simple Bias for Linear

Shunt regulation for bias supplies offers the advantage of low constant-current

With the exception of those circuits using zero bias tubes, class AB2 and class B operation of linear amplifiers appears to have been largely neglected by the radio amateur. The reason for this is not hard to find. The little literature which is available on the subject invariably shows bulky and elaborate regulated bias supplies, often containing five or six tubes, being used to maintain the bias voltage at a steady value while the grid current surges to 100 mA or more with each transmitted syllable. Some form of regulation is, of course, essential, for the bias voltage would otherwise swing wildly with each surge of grid current. But this regulation can be provided so simply using semiconductors that it need no longer influence the choice of amplifier type.

The regulator described in this article possesses the following features: (1) It contains only five small components, costing approximately $3, and requiring about two cubic inches of space. (2) It is a two-terminal device which is connected to the amplifier at the point where regulation is required. No separate power is needed. (3) The bias voltage may be adjusted by the turn of a knob to any value between 40 and 100 volts (other ranges are available by changing the component values). (4) It can be used for any class of amplifier, radio or audio frequency, whether grid current flows or not, but as described above, it is of particular value for class AB2 or class B amplifiers. (5) It will hold the bias voltage within 1.0V of the selected value during grid current excursions up to 100 mA, or within about 4V for a current up to 400 mA. (Closer regulation could be obtained with additional components but is not necessary.) (6) It can be used in conjunction with almost any bias supply of suitable voltage, and only a small current is taken from the supply, regardless of the value of grid current to be handled.

Bias regulation differs from the more common use of regulators in power supplies in that grid current flows backwards into the supply instead of drawing current from the supply. The shunt type of regulator is ideal for this application because it can be designed to draw only a very small constant current from the bias supply and yet accommodate a heavy flow of grid current from the linear amplifier while maintaining the bias voltage constant (see Fig. 1). The more commonly used series regulator does not possess this property, but must be set up for a power supply drain greater than the peak grid current to be catered for (see Fig. 2).

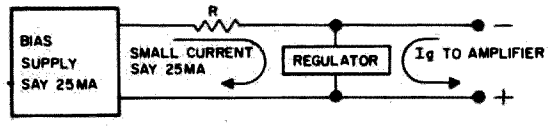


Fig. 1. Shunt regulation.

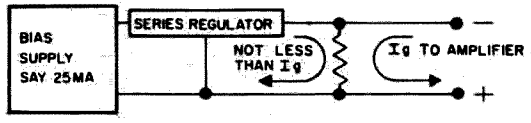


Fig. 2. Series regulation.

Ronald G. Badman, ZL2ANG
5 Brooker Grove
Newlands, Wellington,
New Zealand

Regulator Amplifiers

drain, and it can be used with the neglected class B and AB2 linear amplifiers.

I have therefore based my design on the use of shunt regulation, and evolved the simplest possible circuit that will give adequate regulation plus an adjustable voltage. The practical circuit is given in Fig. 3.

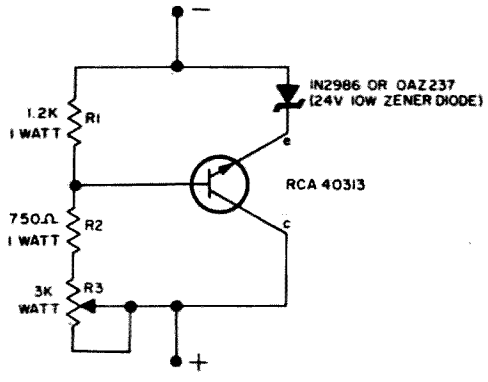


Fig. 3. Practical regulator circuit.

Resistors R1, R2, R3 form a voltage divider which applies a fraction of the total voltage to the base of the transistor, while the emitter voltage is fixed by means of the zener diode. The device regulates in such a manner that the voltage between base and the negative terminal just exceeds the zener voltage. Any further increase in voltage is then opposed by the heavy increase in transistor current which results. The voltage at which the device regulates is changed simply by altering the ratio of the base dividing resistors. The base could be connected to the moving arm of a potentiometer, with fixed resistors from either side of it to the plus and minus terminals, but if this were done, the bleeder current would increase needlessly as the regulated voltage was increased. With the circuit shown, the bleeder current (through R1, R2, R3) remains constant as R3 is varied. To allow for different bias supply units, the series resistor R (Fig. 1) should be chosen so that a current of between 15 and 20 mA flows into the regulator when it is set for maximum voltage (i. e., R3 at maximum). As the regulated voltage is reduced, the voltage drop across R will increase and cause an increase in the current through it and through the regulator. This is of little consequence unless the bias supply is rated at less than 30 mA, in which case R could be made adjustable and coupled to R3; or, alternatively, R could be replaced with a constant-current device. These refinements, however, will not generally be necessary or desirable. The bias power supply unit itself need not possess good regulation; in fact, a poorly regulated supply giving a drooping voltage-versus-current curve is desirable to minimize the current changes described above.

If it is desired to substitute other components or alter the range of the regulator, watch the following points:(1) The higher the zener voltage the better the regulation, but it must be less than the required minimum regulated voltage. (2) The transistor must have an adequate voltage rating. (The RCA 40313, with a 300V rating, is good for the highest bias voltages likely to be required.) (3) Watch the dissipation – transistor and zener both carry the full grid current. (4) Determine the maximum base current (maximum

HUSTLER

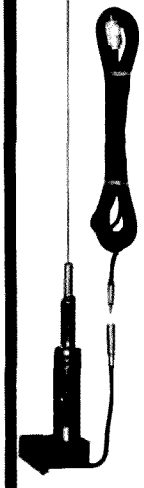
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grid current divided by beta). (5) Select the base divider resistors to pass between 10 times the base current.

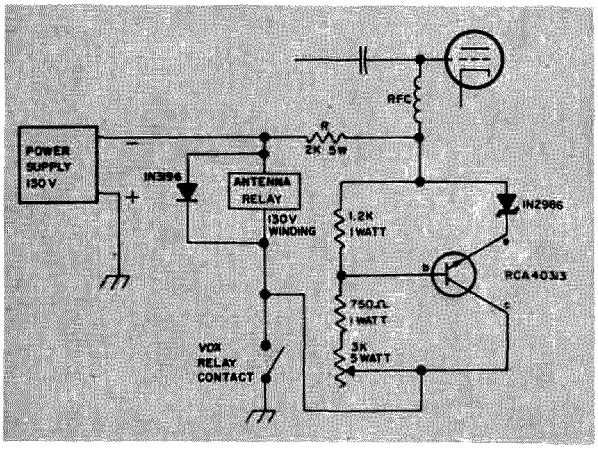


Fig. 4. Biasing the linear amplifier.

Figure 4 shows the regulator in a practical circuit for a linear radio frequency amplifier.

With the VOX relay open, maximum bias voltage is applied to the amplifier to bias it off. When the VOX relay operates, the bias falls to the value set by the regulator, and the antenna relay changes over. The diode shunting the relay coil is to avoid damage to the regulator, due to the "kickback" of the relay winding. Should the "slugging" effect of this diode cause the relay to release too slowly, the diode could be placed across the regulator unit instead. The positioning as shown has the advantage, however, of preventing sparking at the VOX relay contact due to the relay inductance.

If the antenna relay arrangement is not required, simply omit relay and diode from the circuit. If the provision for biasing back the amplifier during standby is not required, the positive end of the regulator should be earthed directly and the transistor case may in fact be bolted to the transmitter chassis without any insulating washer.

I have shown a 130V power supply, but this could be considerably higher (or lower if only a reduced voltage is required). In either case, choose the series resistor R as described earlier.

The circuit of Fig. 4 has been designed to handle a considerable amount of grid current, but the same circuit without any change whatever may be used for class AB1 or other amplifiers which do not draw grid current.

. . . ZL2ANG ■

J. W. Herbert ZL2BDB
3. C. Cumberland Grove
Poiriva East, New Zealand

DESIGN FOR A HIGH PERFORMANCE I-F AMPLIFIER AND AGC SYSTEM

For CW or SSB work, you'll find this system hard to beat with its fast-attack/slow-decay characteristics. A wide latitude of stage gain is assured with both forward- and reverse-acting agc circuit elements.

This paper describes the design and operating conditions of an i-f amplifier which is intended to be part of a complete SSB/CW receiver or transceiver project. It uses modern components and techniques and has extremely good agc characteristics.

The circuit also offers high gain and is ideally suited for both CW and SSB applications, since a fast-attack and slow-decay agc characteristic is available. Although this particular amplifier was designed and tested for use at 9 MHz, the design is equally suitable for any i-f between 50 kHz and 10.7 MHz.

Transistors and AGC Circuits

When transistors were first introduced into rf and i-f circuitry it was generally observed by amateurs that although high stage gains could be readily achieved the circuits did not offer a very good agc performance. Most of the circuits employed simple forward- or reverse-acting agc circuits, offering limited range of gain control.

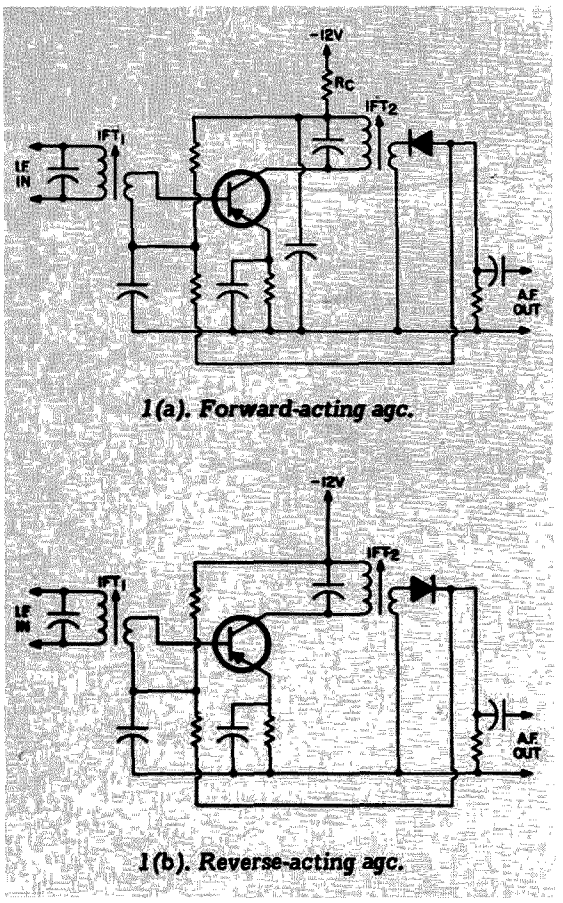


Fig. 1. Simple agc circuits.

Figures 1a and 1b show simple forward and reverse agc circuits. It will be seen that in the reverse-acting agc circuit, the detected i-f signal is fed back as a dc control voltage to bias the transistor amplifier off, reducing the collector current and hence the stage gain. In the forward-acting agc circuit, the dc control voltage biases the transistor on, increasing the collector current. However, due to the presence of a resistance in the collector circuit the collector voltage is decreased, resulting in a reduced stage gain.

The prime disadvantages of such a system, particularly when CW or SSB reception is required, are–

- Limited range of stage gain control
- Excessive agc attack time
- Bfo voltage introduces unwanted agc voltage.
- Detector linearity reduced by agc loading, introducing unwanted audio distortion.

To overcome these difficulties, the circuit described below was developed. It employs both forward- and reverse-acting agc circuitry to obtain a wide range of stage gain control.

Design Considerations

To insure adequate sensitivity in a receiver using an rf amplifier stage, it is generally necessary to have at least 50 dB of gain available in the i-f amplifier. The figure may be estimated by considering the overall receiver gain required from the antenna input to the demodulator stage for a 1 μV input signal.

Assuming a 10 mV signal is required at the product detector, the overall gain required is

$$dB = 20 \log \frac{10 \times 10^{-3}}{10^{-6}}$$

$$= 80 \text{ dB}$$

This gain is shared between the receiver front end and i-f stages and it is reasonable to expect about 30 dB gain from the former, leaving 50 dB to be made up in the latter. It should be noted that these figures include transformer and filter losses in the circuit. Thus, with a 1 μV input signal the i-f amplifier receives an input signal of about–

$$\mu V = \text{antilog} \frac{dB}{20}$$

$$= \text{antilog} \frac{30}{20}$$

$$= 32 \mu V$$

The ability of a receiver to hold its audio output level constant under conditions of signal fading is determined by the agc characteristics. Figure 2 shows the ideal receiver agc characteristics in which the

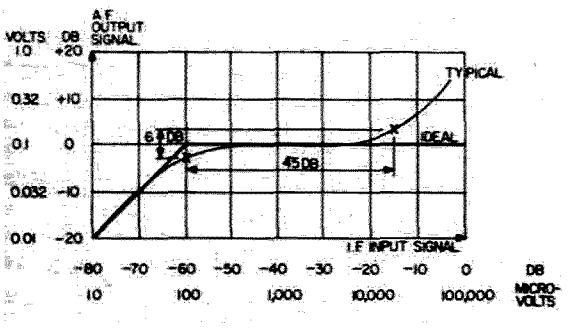


Fig. 2. Ideal and typical agc characteristics. The typical curve shown is that measured for the circuit described in the text.

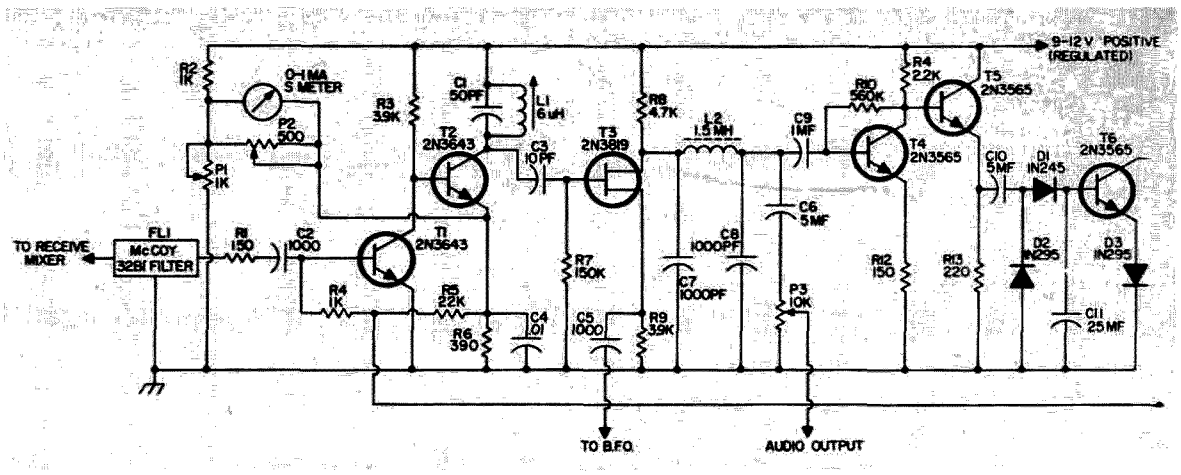


Fig. 3. Circuit diagram of the i-f amplifier, product detector and agc system.

audio output level should increase linearly with increasing signal input from zero up to some threshold level, whereafter the agc becomes effective and holds the audio output level constant even though the input signal level increases. Such a characteristic, particularly if the threshold level is correctly chosen, makes for comfortable operation of the receiver and reduces listening fatigue.

The threshold voltage level is generally chosen to be just above the level of voltage which appears at the detector input due to amplified band noise. Thus, with a front end gain of 30 dB, and assuming a band noise level equivalent to an input of, say, 1.5 μV, the i-f amplifier should have a threshold set to permit agc action on signal levels of greater than, say, 2.5 μV. This represents an input signal of 80 μV into the i-f amplifier, or 25 mV into the product detector before the agc system becomes effective.

I-f Amplifier and Product Detector

The complete i-f amplifier circuit with associated product detector and agc system is shown in Fig. 3. The i-f amplifier consists of dc-coupled transistors T1 and T2, the former of which is an untuned amplifier while the latter employs a tuned collector load. Direct-coupled negative feedback is applied over both stages from the emitter of T2 to the base of T1, insuring stable operation of the amplifier. The overall selectivity of the i-f amplifier is solely determined by the preceding filter unit (FL1). The output is capacitively coupled to the gate of the FET product detector whose high input impedance offers a negligible loading on the collector tuned circuit of T2. A bfo injection voltage of about 2V peak is fed to the drain of the product detector. This stage will handle input voltages up to 1V peak-to-peak before any distortion becomes evident. Since the agc system is effective in reducing any received signal to a level of less than 1V at the product detector input, no i-f gain control is required. The audio output is filtered by C7, C8, and L2 before being applied to the audio volume control and the agc amplifier.

The AGC System

The audio signal from the product detector is amplified by T4 and transformed to a low-impedance source by emitter follower T5. This enables capacitors C10 and C11 in the voltage doubling agc rectifier circuit to charge quickly to speech syllables, giving a fast agc attack time. The rectified audio appears as a positive voltage which is applied to the base of dc amplifier T6 causing it to conduct. Conduction in T6 reduces the base bias applied to i-f amplifier transistor T1 introducing, in effect, reverse-acting agc action.

Due to the direct coupling between T1 and T2, as T1 is reverse biased by the agc action, the collector current decreases, permitting the collector voltage to rise and thus

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forward bias T2 introducing, in effect, forward-acting agc action in the second stage.

The rectified agc voltage decays across capacitor C11, which determines the agc release time.

Circuit Construction and Adjustments

The i-f amplifier/agc system is ideally suitable for assembly on a printed wiring board. Layout is not critical so no detailed construction data is required. The overall gain of the i-f amplifier may be altered by changing the value of R3, increasing the value to reduce the gain and vice versa. The agc decay time may be raised by increasing the value of capacitor C11. It is important that the complete circuit be tested or used, fed from a well decoupled power supply source. It is recommended that a regulated power supply be employed to meet this end.

Circuit Performance

When preceded by a single conversion receiver front end and a crystal filter, the complete circuit gives excellent performance on both SSB and CW signals. AM is of course tuned in the SSB mode by selecting either the upper or lower sideband. Even on the strongest signals likely to be encountered, no overload of the product detector is evident in the nature of a distorted output signal, showing the effectiveness of the agc system.

The complete circuit was subject to laboratory evaluation and the following table summarizes the measured prime specifications—

Parameter	Value
Maximum i-f gain	50 dB
I-f input signal required for agc threshold	100 μV
I-f input signal required for detector overload	250 mV
Change in i-f input signal for 6 dB change in audio output signal	45 dB
Af output signal voltage	100 mV (peak-to-peak)
Agc attack time	12 msec (calculated)
Agc decay time	1 sec

... ZL2BDB ■

Single Sideband on the All Wave Radio



A miniature tunable oscillator provides an ideal source for a beat-frequency signal, and allows you to hear code and sideband on any selective receiver without making modifications to your store-bought gear.

R.E. Baird W7CSD
3740 Summers Lane
Klamath Falls OR 97601

Currently on the market there is a large selection of AM/FM all-wave receivers ranging from solid-state portables for less than $50 to some well over $200. None of these provide for SSB reception. A neighbor of mine recently bought a $200 model for listening to AM, FM, short-wave broadcast, which he thought could be used as a ham receiver for his teenage son. After due experimentation, the gentleman commented, "I paid $200 for this set and I still can't hear what I want to hear!" He was referring to the "monkey chatter" of single sideband without the proper system of detection.

One solution to this problem is the installation of a bfo oscillating at the i-f, but this involves undesirable modification of circuitry and interconnecting wires. This led to development of a modification that solves the problem at the input with no electrical receiver connections. The circuit shown in Fig. 1 is primarily a stable vfo operating at the signal frequency of the SSB station or on a harmonic of its low-frequency fundamental.

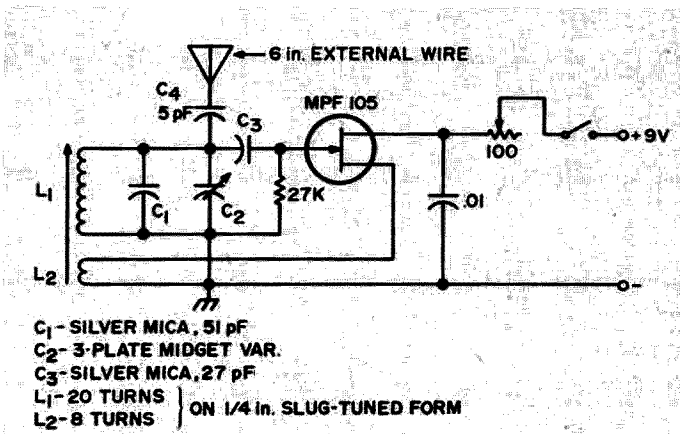


Fig. 1. The tiny oscillator circuit operates from a standard 9V battery. A small hunk of wire provides an antenna sufficient to assure healthy output for several feet. Placed close to a conventional all-wave receiver, the unit provides sufficient carrier injection for copying single sideband and CW.

Since the user was principally interested in the higher frequency amateur bands, the oscillator is designed for the 7 MHz region. It was found that the harmonic content on 14 and 21 MHz was sufficient to deliver the necessary amount of carrier injection for satisfactory reception of SSB signals. This oscillator is designed to supply the missing carrier to the SSB signal, so stability and ease of tuning were of prime concern. At the same time I naturally wished to use junkbox parts as far as possible.

Construction Features

The size of the unit is dictated by the size of the vernier dial used. In my case an old 4 in. vernier dial was resurrected from antiquity as was also the small aluminum box. With a smaller dial the box could be reduced in size materially.

When building a stable vfo, a certain amount of experimenting always seems to be necessary. Cookbook directions are not very helpful. Actually the coil used was a surplus one from which half the turns were removed, leaving L1. L2 was added on the other half of the form in the same direction. (In case the circuit fails to oscillate, reverse the L2 leads. I had to do this because I wasn't sure which way the lacquered L1 was wound.)

In any event, the combination of L1, C1, and the slug may need to be adjusted to cover 7.0 to 7.3 MHz. A silver mica for C1 gives good stability after initial warmup and permits monitoring of SSB signals for extended periods on a basically stable receiver without adjustment. If even better stability is needed, a small disc ceramic, maybe 5 pF, might be reset in parallel with C1. This would yield stabilization by causing drift in the opposite direction. Capacitor C2 is any small midget available.

Operation

After first locating the wanted signal without the bfo, zero in with the bfo. You are trying to tune to within a few hertz and, even with a good vernier dial, this is difficult at 7 MHz. You can easily get approximate tuning. Now the R2 potentiometer comes into play. It was found that drain voltage affected the frequency to some extent, so a 100-ohm pot was placed in series with the +9V and the drain. This seems to provide a very handy fine-tuning device. With this front panel knob you can tune with some precision. If perfect tuning is in the center of the range you will have a quarter of a turn either way for the intelligibility range. With a little practice you will learn how to set the main control for the proper sideband and make final adjustment with the fine tuning.

This device was tried with several all-wave radios which ranged from a 1936 Zenith (the one with the dinner-plate dial), to a cheap transistor set, to a good $200 one. In the case of the Zenith and the $200 Jap job, reception was good enough for serious amateur reception. The cheap transistor set was not too stable itself and requires a bit of signal chasing. Certainly the outboard oscillator was better than the local oscillator in the set.

In general, very satisfactory sideband reception is possible using this front end bfo. And it works equally well for 7, 14, and 21 MHz. . . . W7CSD ■

VACUUM TUBE LOAD BOX

by Jim Ashe

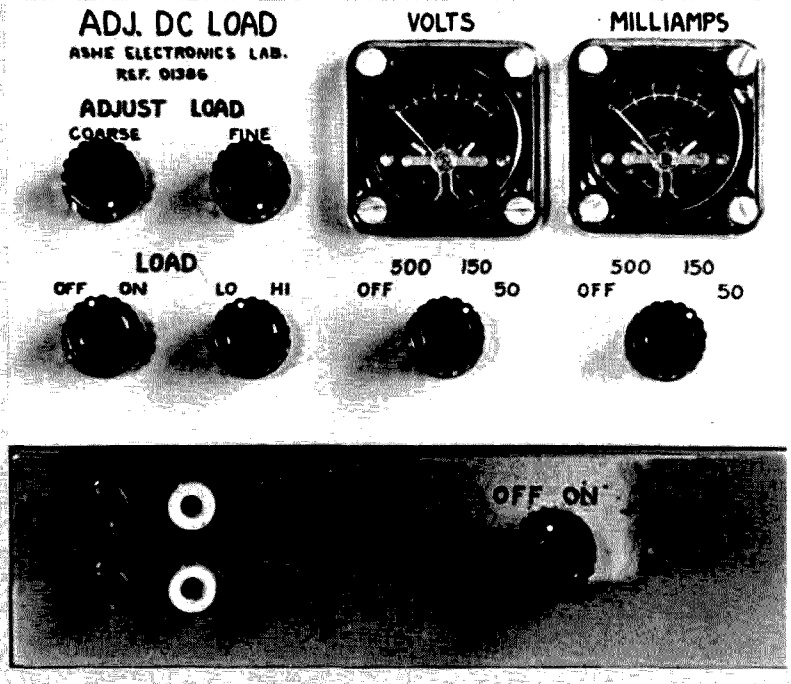


Fig. 1. Front view.

How do you test a power supply? By asking it to supply power. Put it to work, and check its output voltage for various load conditions, its hum characteristics, and its overload performance. These simple, informative tests should be easy, but usually they are not. How about something which will make them nearly as straightforward as testing resistors?

The very simple load box described here uses a pair of 6GE5's as variable resistors to dissipate the supply's power. Its minimum resistance is roughly 1000 ohms and it will load supplies at as low as 30 or 40 volts. The rated dissipation of 35 watts may be exceeded by a factor of two or three for brief tests.

A small part of the power dissipated by the load box goes to heat resistors in the load circuit. Most of it appears at the 6GE5 anodes and is thrown away as heat radiation.

The triode-connected 6GE5's are capable of passing very heavy currents but are restrained to useful loads by an adjustable negative grid bias. The grids draw no current, so large powers can be controlled by adjusting a 2-watt pot. A second pot, in series with the first, serves as vernier and for control of grid voltage at near-zero bias.

Two cathode resistors weaken the dependence of tube currents upon grid bias by adding a little self-bias. This also serves to stabilize and equalize tube loads. By switching two additional resistors across the two permanently installed ones, somewhat higher currents may be drawn for low-voltage test work.

A simple power supply provides heater voltage for the 6GE5's and a well-filtered bias potential. The thorough filtering and neon regulator guarantee that ripple ob-

served in the loaded supply's output originates in the supply rather than the load.

Ballpark accuracy is sufficient for most amateur purposes. Two inexpensive meters of unknown origin serve to indicate voltage and current. The voltmeter multiplier resistors were estimated from the roughly known meter resistance, and then chosen by bench test.

The milliammeter circuit is based upon a 10-ohm wirewound resistor. The current is measured as a small voltage appears across

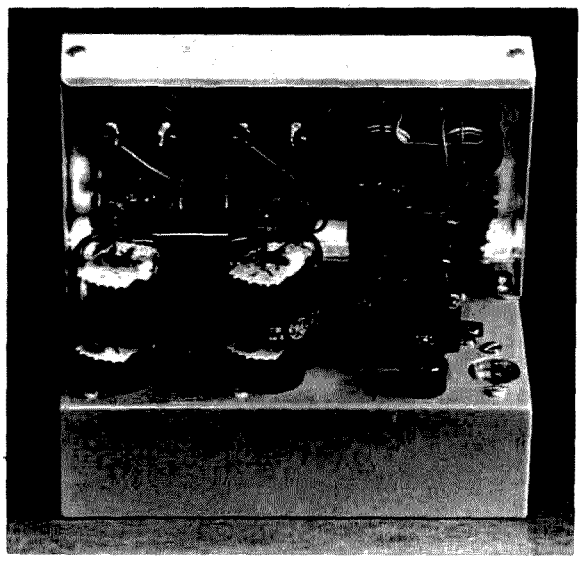


Fig. 2. Back view.

this resistor. Multipliers were chosen to read the voltage, a slight departure from usual practice. A 500 ma range, which may seem a little high, helps avoid pinning the meter when setting up for a test.

When the grid bias is near zero at high anode voltages, relaxation oscillations may occur. Their cause is not apparent. The cathode and anode resistors minimize the nuisance value of these oscillations, which occur only under extreme operating conditions.

Construction

A 5" x 7" x 2" reinforced aluminum chassis provides just enough room for construction. The 6GE5's are placed to the rear, not too close together, for best ventilation. The 4" x 7" front panel was made of .050 sheet aluminum by a local sheet metal shop. It was bent square with a ½" lip at the bottom and a 1¼" lip at the top, bent over again at the back. See Fig. 2. This arrangement makes a very convenient handle. During construction the right angles were adjusted for a rearward tilt of about 5/8". A pair of 1" strips at the sides serve as panel braces.

After completing the metalwork, all parts were cleaned in strong detergent, roughened with wet sandpaper and spray-painted with Rustoleum enamel. Hand lettering with waterproof India ink was covered by a finish coat of clear enamel. The complete process is described in the May issue of *73* Magazine.

Parts arrangement is not critical, except for one circuit. The high-impedance 6GE5 grid wiring should be kept well clear of the ac lines to avoid imposing 60 hz hum on the load box's resistance characteristic. Five lug strips bearing a total of 37 tie points were mounted under the chassis, and 23 points were used in construction.

High voltage dc is hard to turn off without a special switch. This load box used an ordinary rotary switch, and if this switch were opened to break a heavy current, it would arc. A ceramic HV switch is indicated for this application.

Using The Load Box

The load box is very useful for new work, debugging, and for servicing. When initiating

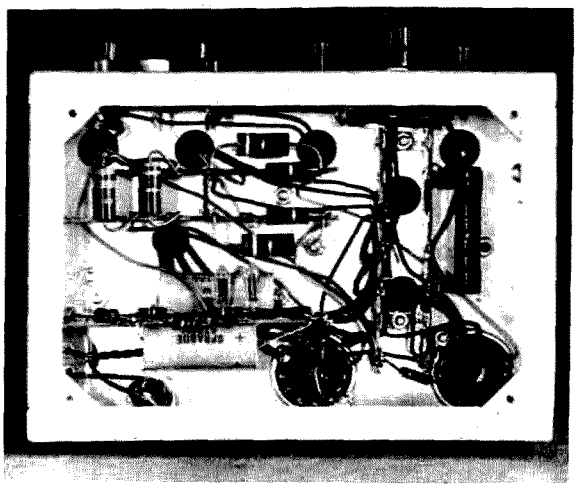


Fig. 3. Bottom view.

a new project, the power supply can be stuck together on the bench and subjected to realistic loads and overloads. When it finally goes into the chassis it can be trusted. If you missed this simple step you may still

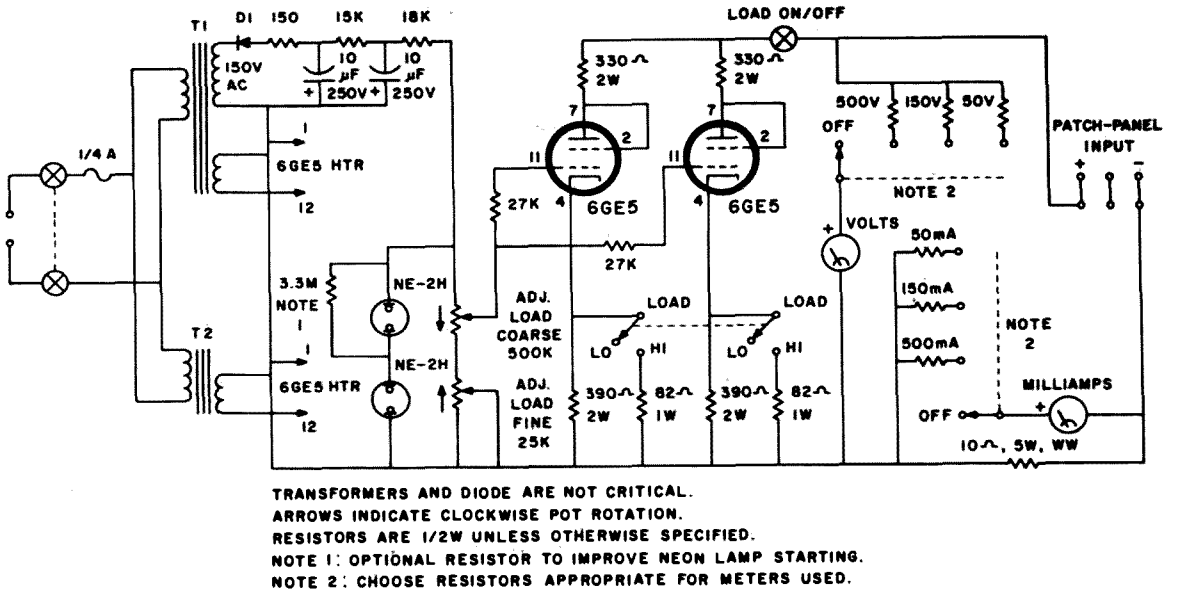


Fig. 4. Schematic.

come out ahead if you use the load box to seek out weaknesses in a supply already built. And it's good for service work too.

If necessary, disconnect the supply from its normal load while the load box is warming up. Choose meter ranges for higher voltage and current than the supply is expected to produce. Turn both adjust controls full anticlockwise, and attach the load box to the power supply.

Turn on the supply, and the voltmeter should indicate the supply's voltage. Turn on the load switch and advance the coarse load control until the milliammeter indicates a current is flowing. An unregulated supply's output voltage should fall as load increases. Make appropriate corrections to meter ranges, and proceed with the test.

If very accurate results are required, the patch-panel input arrangement simplifies the connection of outside meters. These terminals are also handy for attaching an ac voltmeter or an oscilloscope.

The fine load control is used at very low supply voltages, and for zeroing in on preferred voltage or current values when making tests with accurate instruments.

Fig. 5 shows the results of a power supply test. It was a good workout for the load box too, which was used far beyond its ratings.

The upper line is the voltage found at the rectifier output terminal. Regulation here is not good. The lower line shows the regulating circuit output. The regulator tube's 26 watts maximum dissipation will not be

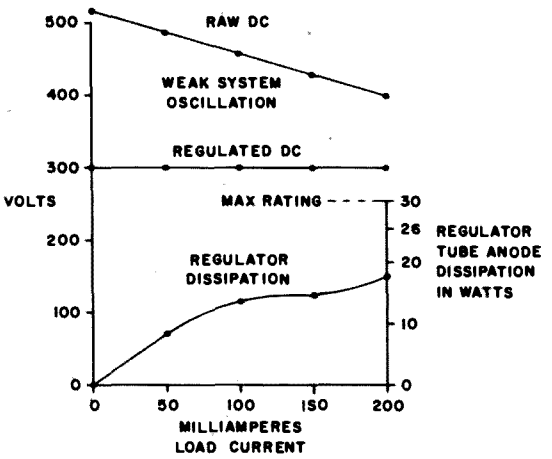


Fig. 5. Test results taken from a regulated power supply, showing regulator dissipation, and regulation well into the anticipated overload region. A few minutes work!

exceeded in normal operation (150 ma), and there is reserve against aging and overload. Looks like this supply should be reliable for long periods of time.

Well, now I guess I'll have to make up a solid state load box!

... W1EZT■

A Directory of American Open Repeaters

An up to date listing of all the open repeaters from coast to coast with information about access requirements where applicable.

Editor's Introduction

For some time now, several people have been independently working toward the preparation of a complete and accurate listing of open VHF FM repeaters in use throughout the U.S. and Canada. As the recent editor of FM Magazine, I have been busy for the past year gathering information by mail from repeater owners who mailed news of their accomplishments to me for incorporation into that journal's periodic directory. Then, a few months ago, I had the opportunity to make several trips across the country by car—which allowed me to personally check the status of repeaters far and wide.

Before starting on my cross country jaunt, I equipped myself with a high-power Varitronics rig and lots of blank paper. Then I proceeded to travel from California, through Nevada and Utah, and returning down through Colorado and other routes through Wyoming, Utah, and Nevada. A week later, going through Arizona, New Mexico, Texas, and Oklahoma, I stopped in Oklahoma City to get a variety of crystals from Sentry for my Varitronics unit, then proceeded through Kansas, Missouri, Indiana, and Illinois.

A short time later, I left the Chicago area and traveled east through Michigan, parts of Canada, New York, and many of the New England states. As a result of these ventures, I was able to glean a great deal of first-hand information about repeaters. The culmination of the records I kept on the trip is reflected in the following repeater directory, which is itself a detailed work containing (1) updated information from FM Magazine, (2) the results of a 73 Magazine survey, and (3) the dedicated contributions of Rick Zach WB2AEB.



Last Minute Notes:

1. The two Hartford area repeaters are off the air due to continuous malicious interference. A 450 repeater will replace the two defunct 2 meter machines . . . W1VVK.
2. Add this repeater to directory:
   WA2UWC Greenbrook, NJ 146.34 to 146.94.
   Machine has sexy female voice for ID . . . WB2AEB.
3. At Potters Peak,near, Wilkesboro, NC, a 6 meter repeater (W4DCD) is now in operation:
   52.78 input get you a 400W signal on 52.525 MHz.
   A 2 meter system is cross connected so that 146.42 MHz is repeated to 52.525 and 52.525 is repeated to 145.05. No tones required. Coverage is 125 miles, unit-to-unit.

by Rich Zach WB2AEB

a word about repeaters

The trend for the future seems to be to use a compatible deviation of both narrowband and wideband rigs by using a wideband receiver and an 8 kHz transmitter at the repeater site.

Many amateurs would like to get involved in FM repeater operation but cannot do so due to a lack of information on local repeaters. We would like to remedy this situation, and thus this directory of open American repeaters is being published. Following is a list of a good number of FM repeaters in the U.S. and Canada. If you know of any other repeaters, or have corrections or additions on the listed ones, please send this information to the editor, to be used in the next update. When giving a report on a repeater, please include the following information (for *open* repeaters only, please):

- ★ Repeater call letters
- ★ Location of repeater
- ★ Elevation of antennas
- ★ Whether wide or narrowband or both
- ★ Inputs and outputs
- ★ Coverage area
- ★ Other features such as open dial or touchtone autopatch, tone burst (CTS will not be listed because this qualifies repeater as being closed).

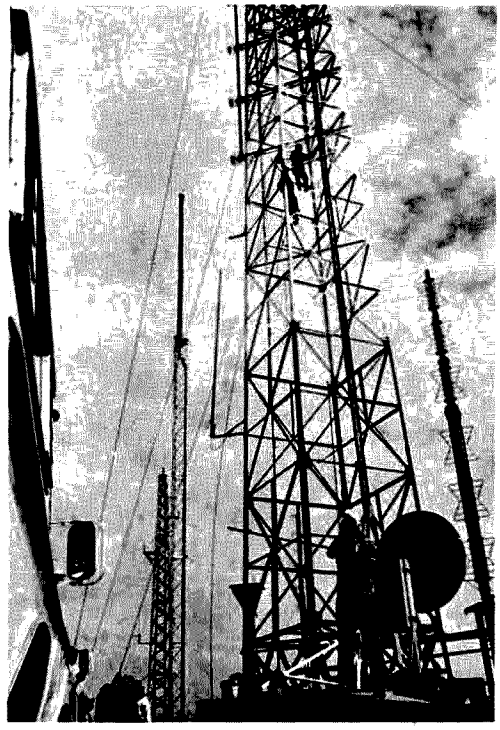
Please be absolutely sure your information is correct and that the repeater is open for use by all radio amateurs. If you see a closed repeater listed, please notify the author immediately.

Needless to say, this directory will be useful not only to the new FM ham, but it will be a good tool for repeater organizations. Much thought on regional and national trends goes into the design of a repeater.

In contributing to this directory, I have found some similarities, some contrasts, and some interesting trivia about FM and repeaters which is not shown on the list itself. You will find that different areas have different repeater outputs and deviation settings. As an example, Florida and Pennsylvania are strongly for narrowband repeaters with .76 out; New York, New England, and most of the rest of the country are strongly for .94 out and wideband. In a metropolis like New York, a ".94 out" repeater would not even be considered due to heavy simplex traffic in that area. Seven-six is used here. Canada tends to favor another input frequency: 146.46 MHz.

The trend for the future seems to be to use a compatible deviation for both narrow and wideband rigs by using a wideband receiver and an 8 kHz transmitter at the repeater site. There is a strong trend for the use of Touchtone autopatch (automatic phone patch) and dial autopatch to a lesser degree. The linking up of repeaters (via UHF "trunk lines") is gaining popularity but not as fast as autopatch. An east coast repeater link-up is slowly growing, but it will not be completed for a few years yet. Another popular practice is to use half-second tone bursts to activate the repeater. Due

to geographical overlap of two repeaters' inputs, you may select which repeater you go through by simply using different tones.

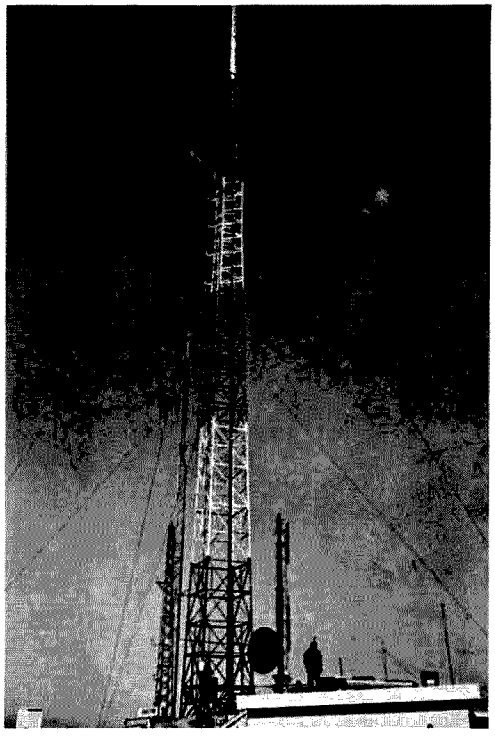


In Chicago, you can pick any of several remote receivers for the big repeater by switching tones. Tulsa has a number of remote receivers for its repeaters, too. However, it uses an automatic receiver voting system which selects the strongest signal then links it up to the transmitter site on top of the National Bank of Tulsa. This is purely a diversity system and tone bursts are not used here.

In some areas, quiet hours are observed. The Albany area is a case in point. It is mutually understood that no repeater transmissions should be made after 2300 hours so that 24-hour-a-day monitoring can be achieved. Other areas use a system similar to this but use a tone burst to open up the monitor's receiver. Many volunteer fire departments use this type of monitor receiver in each of their members' homes.

If you're interested in trivia, the average trustee of a repeater holds an Advanced Class license with Technician class running a close second.

If you like to do things a bit out of the ordinary, take a lesson from two other FM'ers. K2GUG[1] has installed a repeater in a Cessna 180 and W5DFQ has his repeater in a Jeep. K2GUG's is an independent repeater while W5DFQ's can either feed into the Tulsa system or act as a separate repeater.



When it comes to the actual makeup of a repeater, it seems as though GE Progress Line gear is used just a hair more than similar Motorola equipment. This point is the subject of a number of friendly on-the-air rivalries, but in all honesty, this is what a recent poll brought out. Antenna systems are almost always the same. The bigger repeaters tend to use either the Omni-6 by Prodelin the Super Stationmaster by Communication Products Company. These antennas are the undisputed kings of 2 meters FM (with both going for over $160, they had better be!). They are 20 ft omnidirectional antennas which provide 5.8 dB gain in *all* directions. When a repeater group cannot afford one of these gain antennas, generally they use an antenna similar to the Diplomat by Mosley. This type of antenna is a 5/8 wavelength groundplane which provides 3.5 dB gain.

Some repeaters use one antenna for receiving and another for transmitting, but the more well-to-do repeater outfits use the same antenna for both functions simultaneously. This can be achieved through the use of diplexer cavities. You guessed it. . .diplexers aren't exactly dirt cheap!

[1] *QST*, August, 1969, Vol. LIII, No. 8, p. 89 (Bill Smith's "The World Above 50 MHz")

AMERICAN REPEATERS (OPEN)

Listings in this directory are alphabetical by state, area of coverage. This concept (as opposed to a listing by actual repeater location) allows mobile operators to determine with ease the repeaters available for use along any cross-country route.

ALABAMA

W4RFR (wideband)	146.34	146.94
W4VO (Northeast Alabama, Northwest Georgia)	146.34	146.94

ARIZONA

Prescott area

W7AJU (wideband)	146.34	146.94

Phoenix area and extended regions adjacent thereto

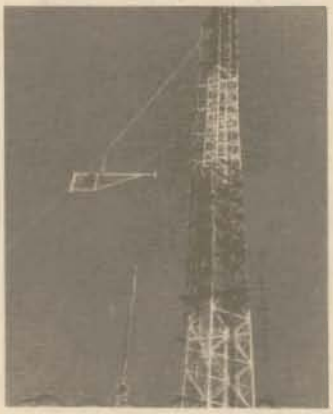
WA7CEM (wideband)	146.34	146.94

Ariz. Rptr. Assn.

Sierra Vista

WA7KYT (wideband)	146.34	146.94

Cochise Amateur Radio FM Assn.





In this photo, a tower arm is being hoisted to the top of the commercial tower where the W7CEM repeater (Phoenix) is located. The arrow shows the almost microscopic figure of one of the braver hams of the repeater group, who will affix the antenna to the arm and fasten the arm brace securely to the tower. The Phoenix "machine" gives a range of approximately 50 miles. (See coverage map.)

ARKANSAS

WA5SNO (Fayetteville; narrowband)	50.50	50.40
W5DI (Little Rock and vicinity; narrowband)	146.30	145.50

CALIFORNIA

Los Angeles area

W6FNO (Radio Ranch)	146.82	146.70

Wideband. Transmissions limited by timer to one minute each. Covers San Fernando Valley, San Gabriel Valley, Pomona Valley, Paradise Valley, most of Los Angeles County, Orange

The Radio Ranch repeater (146.82 to 146.70) in the Los Angeles area has a wide range of coverage with a pattern shaped like a wedge. Terrain features make limits sharp, so that signals drop off suddenly, regardless of mobile power and antenna type.

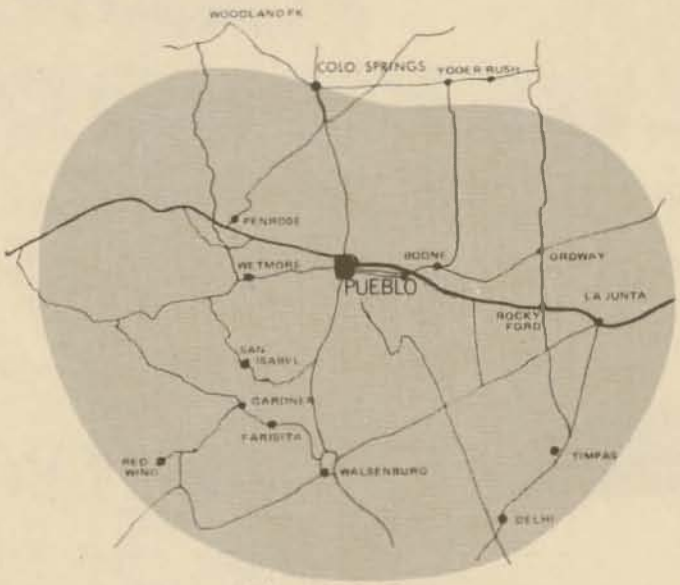


County, parts of Riverside County, and southern third of San Bernardino County. Elevation: 3000 ft. Separate receive and

transmit sites. 35W out. User must whistle (1750 Hz) to activate repeater initially; carrier-operated unless input channel vacated for three minutes.		
WA6UJS (Radio Ranch)	52.76	52.525
Narrowband; 3 kHz in/out. Link planned for coverage from Northern California to Mexican border.		
WA6VFO	146.52	147.18
WA6MPV	145.12	146.90
WB6GUA (Lancaster–Palmdale)	146.34	146.94
Whistle-on		
San Diego area		
WB6DSL	146.34	146.94
Extended Southern California area		
WB6WYM (Twin Peaks)	50.75	52.525
Narrowband. Transmissions limited by timer to three minutes. Covers Lucerne Valley and all of Southern California with the exception of areas shielded by Mt. Baldy, such as San Fernando Valley and some parts of Los Angeles. Elevation: 6000 ft. 100W out. Input deviation: 3 kHz; output deviation: 15 kHz. (Repeater temporarily inactive.)		
No call yet (Tulare Co.)	145.22	146.88
San Bernardino County		
WA6TLL (Bishop)	146.34	146.94
Eastern High Sierra Amateur Radio Society. Can link with Las Vegas and Los Angeles through WB6UGT, WB6SLR, and W6FHF.		
Northern California		
WB6DGT (Humboldt)	146.34	146.94
WB6AAE (Grizzly Peak) Oakland area	146.20	146.80
WB6TSO (Central coastal region)	146.20	146.80
W6NCG (Meadow Lakes, Fresno)	146.85	147.71
	146.12	147.71
WA6YCZ (Mt. Umunhum)	146.85	147.71
W6DOO (Mt. Allison)	146.85	147.71
W6AQU (Mt. Toro)	146.85	147.71
W6AEX (Mt. Vaca)	146.20	146.85
WA6UGY	146.34	146.94
W6CX (Walnut Creek)	147.80	147.06
K6JIM (Central Valley)	146.00	147.70
WB6QEO (San Francisco, east bay)	51.20	51.00
WB6QVV (Placer County)	51.20	51.00
WB6LJR (Santa Clara and vicinity)	51.624	51.024
K6GUE (Sausalito)	145.10	146.60
No call (Solano County)	51.624	51.024
WB6NDJ (Alameda and vicinity)	51.70	51.075
WB6WLV (Narrowband. San Diego Amateur FM Radio Assn.)	146.34	146.85
WA6UGR (Alder Springs)	146.34	146.94
WB6NOJ (East Bay)	51.7	51.075
WA6UGS (Grass Valley)	146.34	146.94
Santa Barbara		
WA6RYX (Narrowband)	146.30	146.995
CANADA		
British Columbia		
VE7CAP (Kimberley)*	146.46	147.33
VE7BTU (Nelson)*	146.46	147.33
*Info supplied by East Hootenay ARC		
VE7MQ (Vancouver to Seattle)**	146.34	146.58

VE7BUZ (Vancouver)	146.34	146.94
VE7AFG (Prince George)	146.58	147.33
VE7APU (Vancouver to Seattle)**	146.33	146.58
**Univ. of British Columbia; precedence given to 146.34 input.		
Quebec		
VE2MT (Mt. Royal, Montreal)	146.46	147.06
	146.46	146.94
VE2RM (Mt. Rigeau; covers Montreal and western portions)	146.40	147.18
VE2OM (Mt. Belair) wideband	146.46	146.94
VE2AT (Mt. Carmel) wideband	146.46	146.94
VE2TA (Mt. Orford; Quebec and northern Vermont)	146.52	147.50
VE2XW (Mt. St. Bruno; Montreal and vicinity)	146.70	147.60
VE2CRA (Ottawa)	146.46	146.94
VE2CTR (Trois Rivieres)	146.46	146.94
VE2FZ (Sherbrooke)	146.46	146.94
VE2CLA (Montreal)	146.10	147.30
VE2CAT (Montreal)	146.18	146.64
VE2PY (Montreal)	146.28	146.88
VE2ZO (Montreal)	146.46	147.06
VE2CRS (Chicoutimi)	146.46	146.94
VE2CSL (Matane)	146.46	146.94
	146.34	146.94
VE2JE (Eastern Montreal)	146.52	147.50
VE2JE (Drummondville)	146.46	146.94
VE2VD (southern Quebec)	146.52	147.50
VE2VD (Quebec City)	146.46	146.94
Ontario		
VE3NPS (Niagara Falls)	146.22	147.24
VE3OSH (Oshawa)	146.40	147.12
VE3RPT (Toronto and extended area)	146.46	146.94
Has secondary output on 147.06		
VE3SIX (St. Catherine)	146.22	147.24
VE3SSM (Sault Sainte Marie; coverage into northern Wisconsin)	146.34	146.94
VE3KSR (Kitchener-Stratford)	146.34	146.94
VE3DRW (Hamilton)	146.16	146.76
VE3NRS (Niagara Falls)	146.22	147.24
VE3STP (Ottawa)	146.34	147.06
VE3PBO (Peterboro)	146.34	146.94
VE3KCR (Chatham)	146.46	146.94
VE3BSQ (Kingston)	146.46	146.94
VE3LCR (Grimsby)	146.52	147.42
VE3MOT (Toronto)	146.58	147.18
Manitoba		
VE4XK (Winnipeg and extended area in southern region)	146.46	146.94
Newfoundland		
VO1GT (Covers all of Cape)	146.46	146.94
Nova Scotia		
VE1ARC (Halifax)	146.46	146.94
VE1VH (Moncton)	146.46	146.94
Saskatchewan		
VE5SS (Regina)	146.46	147.33
Alberta		
VE6AUY (Calgary)	146.46	147.00
VE6WQ (Edmonton)	146.46	147.33
COLORADO		
Colorado Springs		
No call given (Cheyenne Mountain)	146.34	146.94

Northern Colorado		
WØWYX (Denver)	146.34	146.94
WØWYX (Denver)	146.88	146.94



From a high peak in Colorado, the Pueblo repeater provides mobile coverage that transients often find hard to believe. Mobiles have been known to key the machine from as far south and east as New Mexico and Oklahoma.

Western Colorado		
WØPXZ (Grand Junction)	145.32	146.94
Repeater controlled from Grand Junction, deployed at Grand Mesa at height of 11,000 ft. (Highest repeater in the U.S.) Provides coverage over western part of state and into eastern border of Utah.		
WØRRZ (Grand Valley)	145.32	146.94
Used as local backup for Grand Junction repeater; controlled by WØPXZ.		
Pueblo		
WAØSNO (Extended coverage of central portion of state)	146.34	146.94
CONNECTICUT		
K1IIG (Avon Mountain)	146.28	146.94
W1BNF (narrowband)	146.37	146.98
Covers Southern Massachusetts and Eastern Long Island, N.Y., plus much of Connecticut. .94 repeater is tone-burst (1800 Hz).	146.34	146.94
WA1JTB (Bridgeport)		
Covers Southwestern Connecticut. Narrowband	146.31	146.88
W1VVK (Avon)		
Coverage south to Newhaven and East Long Island, N.Y., north to Greenfield; serves as double repeater (prime talkback)	146.94	52.92
K1TKJ (Bantam, Litchfield area)	146.31	146.88
With secondary repeater	146.88	52.98
	53.10	146.31
WA1KFX (Mt. Snow, Vermont)	146.31	146.88
FLORIDA		
Northern Florida		
No call given (Starke)narrowband	146.34	146.94

Central Florida

WB4HAE (Tampa; narrowband)	146.34	146.76
WB4GLK (Okeechobee)	146.34	146.94
Repeater covers central as well as eastern central portion of state; narrowband; repeater functions as double-output, crossed-input system.		
W4CYE* (Cocoa Beach)	146.34	146.76
*Brevard Repeater Assn., Palm Bay, Fla.		
W4IKB (Chipley)	146.34	146.94
W4GGU (Panama City)	146.34	146.76

Northwestern Florida

W4UC** (Pensacola and vicinity; wideband)	146.34	146.76
**Five Flags ARS, Inc. Has secondary output on 146.94		
WA4EVU (Destin)	146.34	146.94
Has secondary output on 146.76		

Southern Florida

Miami; narrowband	146.34	146.76
Trustee K4ANW Ted		

GEORGIA

Northwest Georgia

W4VO (Rome; Mt. Alto)	146.34	146.94
The input and output on W4VO remains the same but because of being almost halfway between Atlanta and Chattanooga, repeater was experiencing a great amount of interference from both cities on .34, so W4VO went to a broadband decoder with a center frequency of 1750 Hz and a bandwidth of approximately 300 Hz. This has eliminated most of the congestion except for an occasional voice falsing it on. Very good coverage for the terrain in this area, about 60 to 65 miles to mobiles in all directions except to NE Alabama where the receiver antenna is shaded by the tower the antenna is mounted on. Whistle-on system. (NW Georgia Amateur Rptr. Assn.)		
WB4NST (Atlanta; narrowband)	146.34	146.76

HAWAII

Diamond Head

KH6EQF (narrowband)	52.525	53.52
(wideband)		146.20
KH6EQF (AM in, wideband FM out)	147.00	146.80

ILLINOIS

Northern Illinois

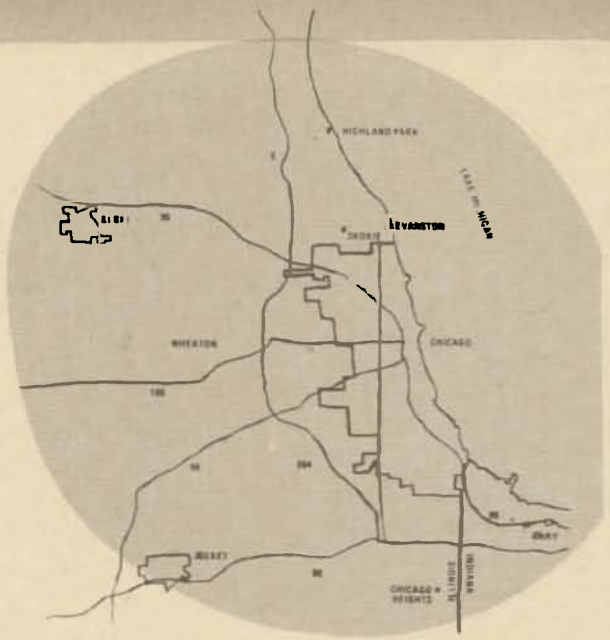
W9YRB (Aurora)	147.40	147.81
W9ZND (Waukegan)	146.46	146.88

Central Illinois

WA9GCK (Bloomington) Whistle-on system	146.34	146.94
WA9EAM (Petersburg)	146.34	146.94
WA9EAT (Joliet)	146.28	146.98

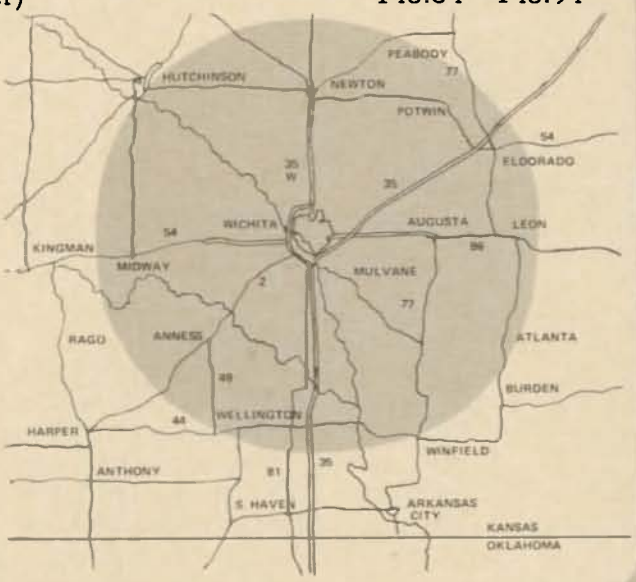
Chicago and vicinity

WA9ORC (Chicago FM Club)	146.34	146.76
1800 Hz tone burst for northside receiver; 2 kHz for southside receiver. Wideband. Timer limits transmissions to 2 min. Two receiver sites. North side tone burst requirement is 1800 Hz. South side burst is 2000 Hz. Coverage includes Waukegan, La Porte, Indiana, Wheaton, Chicago Heights. 60W transmitter at 400 ft level in downtown Chicago. Member ALRA. WA9EAE.		



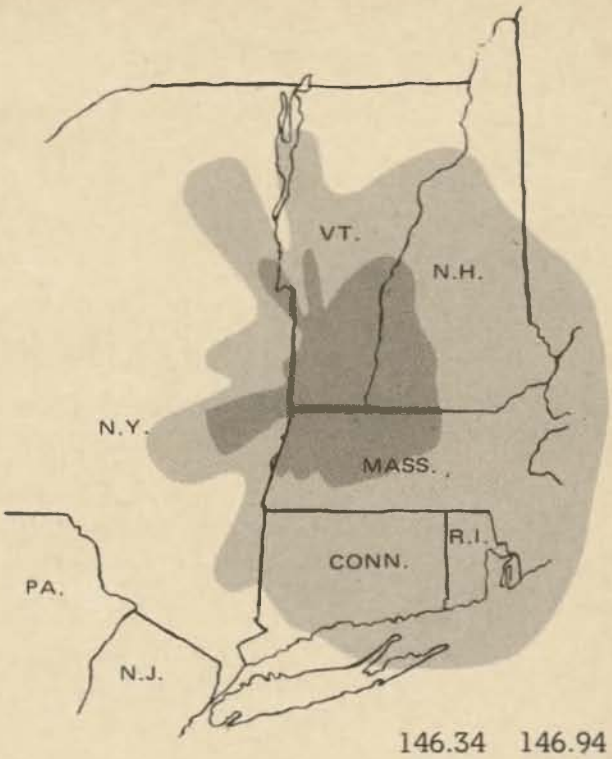
Chicago's CFMC repeater gives an almost perfect circular pattern, and provides highly reliable coverage by virtue of selectable receivers strategically placed in Chicago loop.

WA9EAE	146.46	146.88
WA9ORC (no tone required)	52.760	52.525
W9NGI (SRO CFAR)	147.45	147.75
Rock Island; no call given	146.34	146.94
INDIANA		
Fort Wayne		
WA9EAU (Member ALRA) Ft. Wayne Rptr. Assn.	146.34	146.76
WA9YJV (Member ALRA)	146.46	146.88
WA9YJV	52.640	52.88
South Bend area		
WA9GOP	146.46	146.88
No call given	146.94	52.525
Schererville		
W9EHZ (Midwest Repeater Assn.) 100 ft tower, 250W transmitter	146.34	146.94
IOWA		
Clinton area		
K9ITW (Open system, but privately owned)	146.34	146.94
WA8PUD (Two-site system)	146.34	146.94
KANSAS		
Northeast Kansas		
WAØSNP (Topeka; wideband repeater)	146.34	146.94



The famed Wichita repeater is used by local government as a quick-responding emergency communications system. The well-trained repeater users monitor continuously, and provide valuable tornado warning services by strategic deployment of mobiles throughout the coverage area.

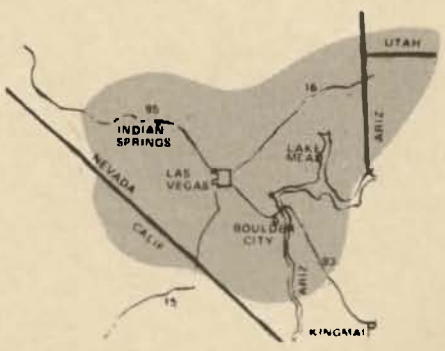
WAØOFH (Kansas City; wideband)	146.34	146.94
Under same call, but narrowband	52.70	52.525
Central Kansas		
No call given (wideband)	146.34	146.94
Coverage from Canton extends to McPherson, Kansas. Member ALRA		
WAØCJQ (Salina)	146.34	146.94
Southeast Kansas		
WØDKU (Wichita)	146.34	146.94
Covers southeastern and south central portion of state. Input continuously monitored. If output is not operational, a request on the input frequency will bring activation. Narrowband.		
WØIPB (Wichita)	146.22	146.82
KENTUCKY		
W4MOP (Louisville, Jeffersontown)	146.34	146.94
LOUISIANA		
Alexandria		
K5URH	146.34	146.94
Baton Rouge		
WA5RTZ	146.34	146.94
Galliano		
W5MCC	146.34	146.94
	146.94	146.76
MARYLAND		
Baltimore and extended ranges surrounding		
WA3DZD (Harmans)	146.34	146.76
WA3DZD	52.525	146.82
No call given	146.22	52.525
W3JCN (Silver Springs)	146.34	146.76
MASSACHUSETTS		
W1ELU (Marlboro)	146.34	146.94
	146.22	146.94
No call given (Lenox; Eastern Mass.) Mass. FM Assn., Inc.	146.25	146.94
(Same system, 2100 Hz tone burst or whistle)	146.34	146.94
W1VAK (New Bedford)	146.34	146.94
W1ALE (Concord, N.H.)	146.34	52.525
Covers northeastern portion of Massachusetts; timed for periodic duty cycles.	146.34	146.94
W1BL (Princeton)	53.54	50.50
No call given (No. Adams)	146.34	146.94
MICHIGAN		
Detroit		
K8PZL (Wideband; not open to base stations) Great Lakes Repeater Assn. Member ALRA	146.34	146.76
Pontiac – Rochester		
No call given	146.46	146.94
Kalamazoo		
K8TIW	146.34	146.94
Grand Rapids		
WA8PUD	146.34	146.94
MINNESOTA		
WØPZT (Hennepin County)	146.54	146.85
MISSISSIPPI		
WA5UEG (Bay Saint Louis; wideband)	146.34	146.94
MISSOURI		
Kansas City area		



Large shaded area shows approximate base station coverage of K1KFX repeater at Mt. Snow. The smaller shaded area shows the 75% coverage limit for typical mobiles using the repeater (.31 to .88).

WAØOFH (KC, Mo. and Kansas)	146.34	146.94
	52.70	52.525
KØOKI	52.88	52.525
WAØAMR (KC, Mo. and east)	146.34	146.94
KØFRA (Occasionally active)	52.70	52.525
Saint Louis		
WAØCJW	146.34	146.94
MONTANA		
Butte; Anaconda		
No call assigned yet	146.34	146.94
NEBRASKA		
Omaha		
WØEQU*	146.34	146.94
*Ak-Sar-Ben Radio Club		
NEVADA		
W7AKE	53.175	52.525
W7AKE (9,000 ft, Angel's Peak)	147.18	147.84

All inputs and outputs are normally in an "on" state at all times, and are automatically selected by keying the input desired. No "lockout" devices are used...the machine is a completely open repeater at all times. Elevation: 8989 ft.

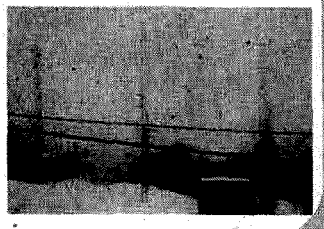


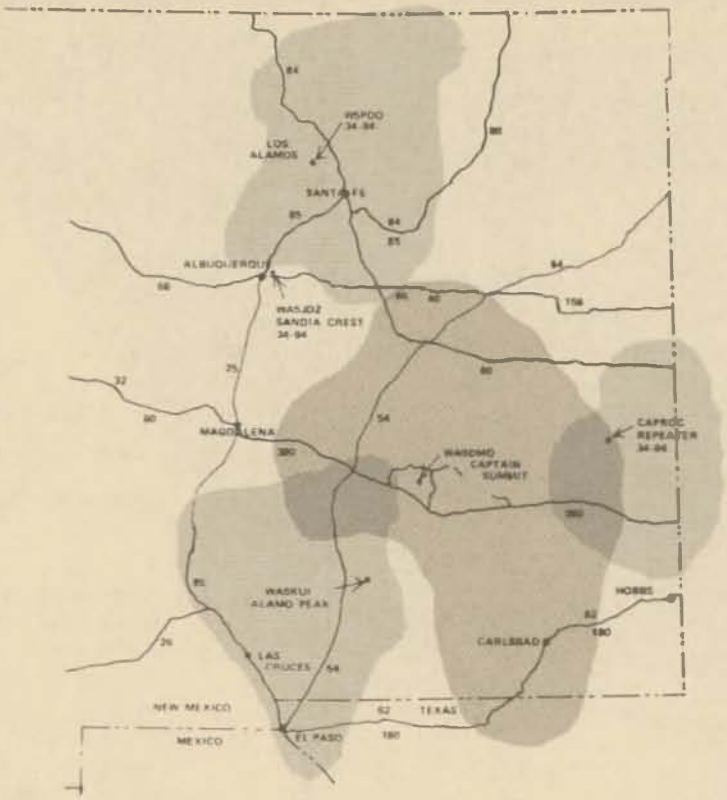
The Las Vegas repeater provides mobile coverage in four states, but its California range is sharply limited by a mountain range near the border.

K7TDQ	146.34	146.94
W7DDB (intermittent)	146.94	147.84
Boulder City		
Gradual upswinging whistle turns on; downswing whistle turns off	146.34	146.94
Reno		
K7UGT	146.34	146.94
NEW HAMPSHIRE		
Manchester		
WA1KFV	146.25	146.76
Whistle on. Covers southern New Hampshire, northeast Massachusetts, south to Boston, west to Worcester. (Member NHFMA and ALRA.)		
WA1KFV (Whistle-on. Coverage as above.)	52.88	52.525
W1ALE (Concord)	146.34	146.94
	146.46	52.525
Covers Southern New Hampshire, Southeast Vermont, Northeast Massachusetts. Timed for periodic duty cycles. Both listed repeaters located at same site. (Member ALRA.)		
WAINR (Derry)	146.19	146.85
	146.34	146.94
Whistle on. Coverage is same as that listed for W1ALE. Wideband. New Hampshire FM Assn. (Member ALRA.)		
WA1KFV (Manchester)	146.34	146.94
WA1KFX (Mt. Snow)	146.34	146.94
Covers South Vermont, Southwest New Hampshire, Northwest Massachusetts, and Albany, N.Y. Operated by Northeastern FM Assn.		
Tone-burst 1800 Hz	146.31	146.94
Tone-burst 1950 Hz	146.34	146.94
Tone-burst 2250 Hz	146.34	146.88
NEW JERSEY		
WA2UWO	146.70	52.64
	52.56	146.76
	146.28	146.76
	146.34	146.76
Provides coverage throughout northern area of state	146.34	52.64
Call not given (Brunswick)	146.34	146.94
Provides coverage throughout state.		
W2CVT	146.37	146.76
NEW MEXICO		
WA5KUI (Alamogordo)	146.34	146.94
WA5JDZ (Albuquerque)	146.34	146.94
WA5GFS (Portales)	146.34	146.94



Atop 10,700 ft Sandia Crest in New Mexico, Dr. Phil Dater takes a day off from his medical practice to hang a 450 MHz antenna in 20-below weather. The Sandia Crest repeater, WA5JDZ, provides coverage from Santa Fe to Socorro and interlinks with two other repeaters, WA5MQ and WA5KUI. The coverages of the three are shown in the map.





K5CQH (Albuquerque)	146.46	147.06
WA5DMQ (Roswell)	145.50	146.50
W5PDO (Los Alamos)	146.34	146.94
No call given (Caprock)	146.34	146.94

All New Mexico repeaters are free access (no tones) and narrowband FM.

1: New Mexico Repeater System – three repeaters linked to give almost border-to-border coverage.

WA5JDZ, Sandia Crest (near Albuquerque); 146.34 MHz in and 146.94 MHz out; owned by Philip H. Dater M.D., Albuquerque.

WA5DMQ, Sierra Blanka (near Roswell), 145.5 MHz in and 146.5 MHz out; owned by Ken Letcher, W5YFN, Roswell.

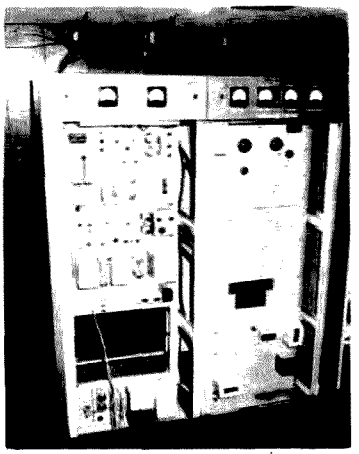
WA5KUI, Almo Peak (near Almogordo), 146.34 MHz in and 146.94 MHz out; owned by Donald Scott, Alamogordo.

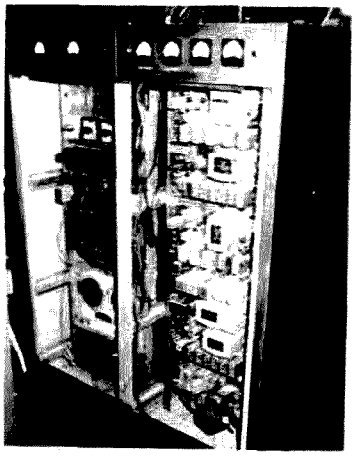
2: W5PDO, club station, Los Alamos Radio Club, 146.34 MHz in and 146.94 MHz out; covers 50 mi. radius of Los Alamos.

3: WA5VKY, club station, Amateur Radio Caravan Club of New Mexico, located at Sandia Crest (10,600 ft elevation), 146.46 MHz in and 147.06 MHz out; covers presently about 50 mi. radius of Albuquerque; however, the transmitter is copyable throughout New Mexico and into adjoining states. A better diplexer and remote receivers should give the repeater better ears and extend the coverage to about 200 mi. radius.

4: K5CQH, located in the Monzano Mountains (7730 ft elevation) about 20 miles southeast of Albuquerque, 146.46 MHz in and 147.06 MHz out – backup for WA5VKY in case it blows up. Also 147.06 MHz in and 147.72 MHz out. This one picks up a few canyons close to Sandia Crest that the Crest signal squirts across and not into.

The transmitters, amplifiers, and power supplies of the WA2UWO repeater are shown in the photograph at left. The other two-bay cabinet, pictured at right, contains the system receivers, relays, control elements, and log recorder. The ready-made commercial cabinets have the advantage of providing built-in meters for measuring all the important parameters of the repeater transmitters and receivers. The equipment shown is 100% General Electric.





NEW YORK

Long Island		
W1BNF (Connecticut; narrowband)	146.37	146.98
Northern New York		
No call yet (Whiteface Mountain) N.A.R.A.	146.22	146.76
W2CVT (Mt. Beacon) (local)	146.34	146.76
(wide area)	146.37	146.76
Albany		
W1JTB	146.31	146.94
East New York		
K2AE (Schenectady)	146.46	146.94
Operates from approximately 7 a.m. until 11 p.m. daily, under the auspices of the Schenectady Amateur Repeater Club.		
WB2NNZ (East Central N.Y.)	146.34	146.94
Operated by the TELCO Club		
W1KOO (Mt. Mansfield, Vt.)	146.37	146.94
	146.34	146.94
Operated by the Burlington, Vermont Amateur Radio Club.		
W1ABI (Killington, Vermont)	146.34	146.94
Whistle on. Operated by the Northeast Vermont FM Rptr. Assn. Member ALRA.		
Central New York		
K2GVI (Utica-Rome)	146.34	146.94
WB2NNZ (Troy)	146.34	146.94
Also covers eastern part of state. TELCO club.		
W2DEG (Grafton)	146.22	146.76
W1ABI (Killington; whistle on.)	146.34	146.94
WA2VNU Cross-connected system	146.34	52.72
	52.80	146.76
Syracuse		
W2RIL	146.46	146.94
W2YRL	146.46	146.94
Lockport		
W2RUI	146.25	146.82
Buffalo		
K2GUG	146.34	146.94
WB2TLJ	146.34	146.94

NORTH CAROLINA

North Central area		
WA4FYS (Burlington)	52.76	52.525
Has secondary output on 146.98		
Western area		
W4WID (Lenoir)	52.76	52.525
W4DCD (N. Wilkesboro)	52.525	146.90
W4DCD (Secondary of cross-connected system)	52.78	52.525

OHIO

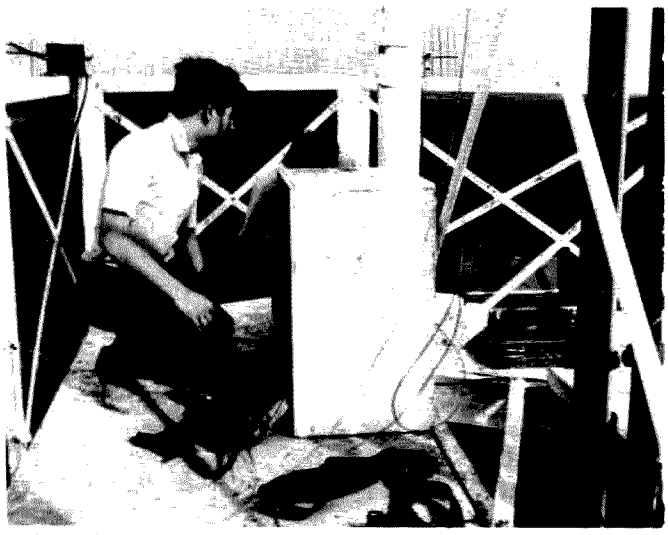
Dayton (all of Montgomery County)	146.34	146.76
Delaware County		
W8AIC	146.34	146.94
Has secondary output on 146.76		
System is a wideband type and may be actuated with a whistle on the input. Replaces W8LGL.		
W8QLS	145.62	146.97
Civil Defense repeater; G. Cryder (W8LGL) operates.		
Toledo		
Call unknown (wideband)	146.34	146.94
Youngstown		
W9IOO	146.34	146.76
Cleveland		
WB8CQR	146.34	146.76
WB8CRV	146.88	146.40
Other areas of state		
No call given (Lorain, tied in with WB8CRU)	146.52	146.76
WB8CRU (Newcomerstown)	146.34	146.76
No call yet (Pittsburgh)	146.34	146.94

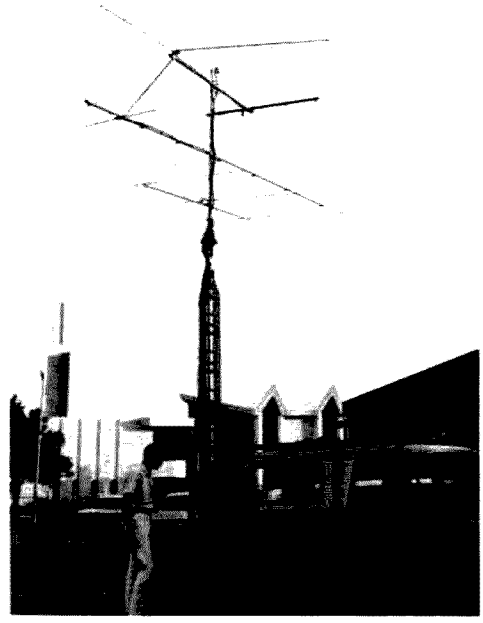
OKLAHOMA

Central/Eastern Oklahoma		
WA5LVT (Tulsa)	146.34	146.94

The repeater has its main transmitter at the National Bank of Tulsa Building with a satellite transmitter just installed at Bartlesville, Oklahoma operated by K5YZO. Main transmitter output is 450 watts. Satellite transmitter power is 15 watts. The system receives on 3 remote receivers located around the area. The highest receiver site is on the Channel 6 TV tower north of Sand Springs, Oklahoma. Other sites are Fort Gibson

(below)
WA5QGN and WA5QMZ work on the package containing the control link receivers and transmitters, at the 250 ft levelof the local television station's tower. The 450 MHz control equipment is mounted at the 250 ft level. The gear for the 2 meter repeater is up a breathtaking 500 ft.

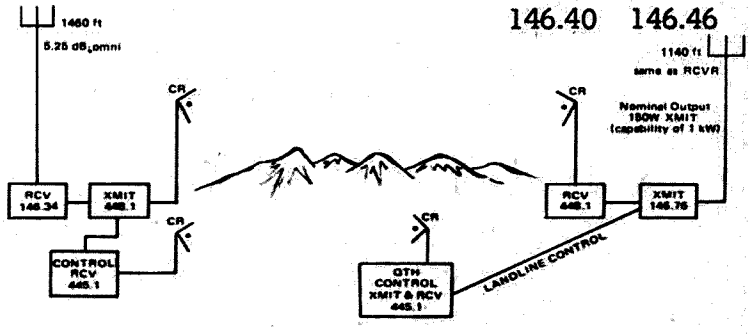




(right)
Not all repeaters are fixed-site types. More and more amateurs are putting together portable repeaters capable of operating from emergency power sources. Not only does this concept provide an attractive "package" for local Civil Defense and disaster teams, but it serves as an ideal "backup" system in the event something goes wrong with the regular local repeater. This setup is the W5DFQ repeater, and includes a 30 ft crank-up tower outfitted with directional and omni antennas for 6 and 2.

lake near Wagoner and South of Tulsa on a water tower. There is also a standby receiver and transmitter located at the Trustees house in southeast Tulsa. All sites are interconnected and controlled on 440–450 MHz.

Oklahoma City		
No call assigned yet	146.34	146.96
Bartlesville		
WA5LDB	146.34	146.94
OREGON		
W7DBS (Eugene)	146.34	146.94
W7VS (Portland)	146.34	146.94
K7UGN (Extended coverage over Portland and neighboring cities)	146.76	146.58
No call given (Newport)	146.76	146.94
No call given (Dalles area, from Mt. Livingston)	53.46	52.92
No call given (Pendleton area, Mary's Peak)	146.34	146.76
No call given (La Grande area)	146.34	146.76
W7OFY (Medford area; King Mountain)	146.34	146.94
PENNSYLVANIA		
Philadelphia		
WA3BKO	146.34	146.76
WA3IGS Cross-connected system	52.80	52.72
	146.28	146.76
Coatsville (PL required)		
K3ZTP	146.22	146.82
Pittsburgh		
K3UQD	146.34	146.94
Alternate system:	146.34	146.76
Other areas		
K3PQZ (York)	146.34	146.76
WA3ICC (Harrisburg)	146.34	146.76
WA3KUW (State College)	146.34	146.76
No call given (Sayreville)	146.40	146.46



Control and deployment of WA3ICC repeater in Harrisburg, Pennsylvania. All QSOs are taped and time is automatically logged from 24 hr. tape, which advances every min. Time is logged only after QSO.

RHODE ISLAND		
Providence		
W1CDO	146.34	146.94
Has secondary output on 52.525		
SOUTH CAROLINA		
Call not given (Central portion of state)	52.76	52.525
Call not given (Central portion of state)	146.34	146.94
TENNESSEE		
Memphis		
W4CV (Tri-State Am. Rptr. Assn.)	146.34	146.94
Nashville		
No call given (Double repeater system)	146.22	146.94
No call given	146.94	146.20
Chattanooga		
WB4KLO*	146.34	146.94
*Chattanooga Tri-State FM Assn., Inc.		
Shelbyville		
W4IWV	146.34	146.94

TEXAS

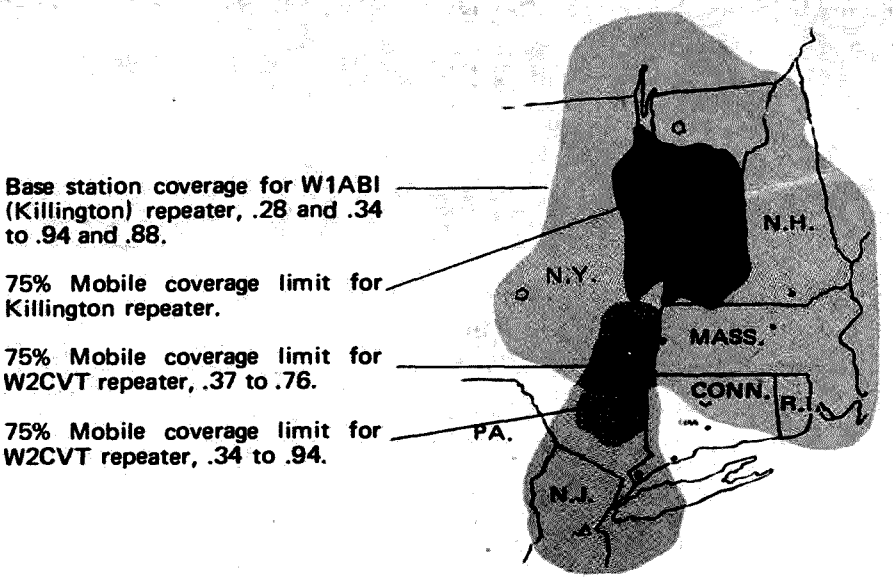
Fort Worth and vicinity		
No call given	53.05	53.15
WA5KTO (Texas VHF FM Soc.)	146.34	146.94
	146.16	146.76
Lubbock		
W4FXC/5	146.34	146.94
W5YUO	146.16	146.76
Dallas		
No call given	146.22	146.82
No call given	52.85	52.95
No call given	146.34	146.94
Houston		
WA5QLA	146.28	146.88
Austin		
W5NFC	146.34	146.94
San Antonio		
No call given	146.34	146.94
Amarillo		
W5CBT	146.34	146.94
Other areas		
WA5LDL (Tyler)	146.34	146.94
No call given (Port Arthur)	146.34	146.94
No call given (Midland)	146.34	146.94
No call given (Abilene)	146.34	146.94

UTAH

East border		
WØPXZ	145.32	146.94
Provides coverage from 11,000 ft site at Grand Mesa, Co.		
Salt Lake City (intermittent)		
WA7AKI	146.34	146.94
Provides coverage over Northern Utah and Southern Idaho		
K7OEP (Southern Idaho)	146.34	146.94
WA7GTU (Cedar City; narrowband)	146.34	146.94

VERMONT

Central Vermont		
W1ABI (Killington)	146.34	146.94
1800 Hz Tone burst	146.28	146.88
Northeast FM Rptr. Assn. 2100 Hz tone burst	146.34	146.88
Southern Vermont		
WA1KFX (Mt. Snow)	146.31	146.88
Provides coverage over southwestern part of state		
W1ALE (Concord, N.H.)	146.34	146.94
Provides coverage over south and southeast portion of state, overlapping with other states. Repeater timed for periodic duty use.		
Alternate system	146.46	52.525
K1MNS (Derry)	146.25	146.76
Southeast and south part of state		
Northern Vermont		
VE2TA (Quebec repeater)	146.52	147.50
W1KOO (Mt. Mansfield)	146.34	146.94
2400 Hz tone-burst entry. Covers northern portions of Vermont and northeastern regions of New York. Operated by Burlington Amateur Repeater Club.		
No call assigned yet (Northern Vermont)	146.22	146.82
No call assigned yet (Northwestern Vermont)	146.22	146.76



VIRGINIA		
Lynchburg		
WB4HCX (Lynchburg ARC; GE employees)	146.34	146.94
Repeater operates wideband input, narrowband output.		
W4GCE	146.22	147.42
Has secondary in/out on .941.76)		
Other areas		
K8SXO (Ridgeley)	146.76	52.525
Cross-connected double repeater	52.525	146.76
W4DXC (Richmond)	52.72	52.640
WASHINGTON (STATE)		
Northern Washington		
VE7MQ (British Columbia repeater)	146.34	146.58
Provides extended coverage in northwest part of state		
VE7APU (British Columbia)	147.33	146.58
Provides coverage in northwest, Seattle to Vancouver		
No call given (Seattle)*	146.34	146.58
	146.76	146.58
W7PUG (Seattle)	146.34	146.76
*Seattle repeaters interlinked with precedence to 146.34 input.		
K7KSZ	52.525	53.290
W7AJF (Upper state)	146.58	146.76
Eastern Washington		
W7AAG (Spokane)	146.34	146.76
Other areas		
W7DAQ (Longview)	146.76	43.290
Intermittent operation; precedence given to 146.76 input; double repeater		
No call given (Richland)	52.525	53.290
No call given (Yakima)	146.26	147.21
WASHINGTON, D.C.		
WA3DZD	146.34	146.76
WISCONSIN		
W9ROM (Milwaukee)	146.34	146.76
K7SDD (Sherman Hill)	146.16	146.76
Linked to WA7EGK and Denver's WØWYX on Casper Mt.; includes Touchtone autopatch.		
W7LVU (Casper Mt.)	146.34	146.94

FM Repeaters under fire from FCC

An FCC move feared by all FM'ers since it was first publicized in FM Magazine back in March 1968 has finally happened: The FCC has docketed a set of repeater rulemaking recommendations that are so constricting as to destroy half the repeaters in the country. What are these earthshaking comments?

1. No crossband operation. Period. This means that no one will be able to operate through his repeater from 450 MHz. This means that remote operation of transceivers will be illegal. This means that site-to-site links will be illegal, unless they are interconnected via a wire line.
2. Only one transmitter can be energized per receiver, and signals cannot be re-repeated. This means no multiple-output repeaters; no links, no cross-connected repeaters, and no cross-country systems.
3. Transmitters and receivers of repeaters will be authorized on specific subbands only. Here are the catastrophic subbands proposed:
   - 6-meter repeaters must receive between 52.5 and 52.7, and must retransmit the signals between 53.0 and 53.2.
   - 2-meter repeaters must receive between 146.3 and 146.6, and retransmit the signals on the frequency range of 146.9–147.2.
   - UHF repeaters must receive in the range of 447.7–447.9, and retransmit in the range of 449.1–449.3.

The implications of the foregoing are obvious. Prime repeaters are okay on .94, but all the .76 systems will be defunct. Talkback repeaters will be completely wiped out. The UHF transmit-receive spread is only two megahertz, which will all but eliminate all but multiple-site, wireline interconnected repeaters.

There are a number of other restrictions, such as a 600W power limit, mandatory tone access, relaxed logging. Most of the other restrictions can be lived with, but repeaters cannot survive with the restrictions as noted above.

The FCC will accept comments from individuals interested in repeater rulemaking until May 15. Let no grass grow under your feet. If you haven't already made in issue of this, do it now. Call your club together for an emergency meeting and start putting together your comments formally. Mail them (and 14 additional copies) to the FCC in Washington, D.C.

Urge the FCC to accept RM-1542 without change. It is reasonable constricting, but in the best interest of amateur radio. It, too, requires mandatory tone control, for example, but only as an alternative to continuous monitoring from the UHF control frequency. RM-1542, submitted in December 1969, asks that the FCC relax logging in favor of a "technical log." It asks that control of the repeater be permitted by tones from the frequencies of use INSTEAD of requiring a UHF monitor at a fixed control point. RM-1542 is a good proposal and it is in the best interest of the public and the amateurs. If the FCC would accept RM-1542 without change, and reject the recommendations offered in Docket 18803, repeater operation would grow and thrive, and optimum use of the spectrum would be assured.

. . . K6MVH ■

the fine points of FM peration



Richard J. Zach WB2AEB
22 Pike Place
Mahopac NY 10541

Another installment in a continuing series of FM "beginner" articles.

After you get set up on FM, you'll find that you will be doing a lot of monitoring. To the seasoned HF operator this may seem quite futile. However, with simultaneous signals FM receivers have a property of receiving the stronger and almost completely rejecting the weaker one with little or no heterodyne. Also, all FM communications receivers (except for a few pocket pager types) have a rather sophisticated squelch circuit. When it comes to receiving a weak FM signal, the modulation does not steadily decrease with the signal strength, but is nearly "armchair copy" to a critical point. Once the signal gets below this point, it drops completely out of the picture and the squelch will close. Roll all these properties into one receiver and monitoring will be a joy. When a signal is received, chances are that it will be just one clear, fully modulated voice. When there is no signal you will hear nothing but silence . . . no QRM or static, just silence.

This all sounds like an ideal situation, and it is. However, the transmitting station must do his part too. His signal must conform to certain standards. His center frequency must not be far above or below the accepted channel: deviation must not be far above or below the accepted value in that area, as well as other criteria. The only way that we can keep the operating channels clean is to

continuously monitor each other's transmissions and give constructive criticism. Actually, this is not very different from other modes.

The equipment used to analyze FM transmissions is either superexpensive or extremely cheap. If you have ever priced digital frequency meters or deviation meters, it is not hard to tell which method is the expensive one. The inexpensive method is quite simple and accurate and I claim no originality for it. The equipment described (except for the oscilloscope feature) is in operation in about 90% of all the metropolitan New York base stations. As you can see in Fig. 1, it is nothing but a switchable meter to read limiter current (signal strength) and discriminator current (frequency).

If the discriminator reads zero, the received signal is exactly on your frequency. The meter can be calibrated in kHz off frequency by experimentation. For the initial setup you should use a good frequency meter or a station that is the frequency standard for your area (usually a repeater). However, make sure you know that your frequency standard is actually on frequency. Also, when giving off-frequency reports, make sure that you are on frequency, too. If the discriminator-meter needle wiggles, the received station's modulation is asymmetrical (swings more in one direction than the other) and should be corrected. Without the meter you might think that his deviation is too high due to distortion on the peaks.

The limiter current reading is only a reading of relative signal strength and should not be compared with other receivers. As an example, a typical GE Pre-Progress Line (Pre-Prog) receiver may give a reading in the teens for an excellent signal. A Progress Line receiver may show a 100 μA reading for the same signal. These readings vary even in identical receivers. In other words, become familiar with your receiver's meter and express the signal's figure of merit accordingly. When receiving a strong signal, check to see if the limiter current changes with the modulation. If it does, this is a sign of AM'ing and should be looked into.

Walt Guderian (WB2RAA) showed me a nice little trick using the oscilloscope. Almost any inexpensive scope will work. Connect the vertical input to the discriminator jack and put a slow (under 100 Hz) sweep on the horizontal plates. When no signal is received, you will see a pattern like in Fig. 2a. This is just noise on the discriminator. Receive a full-quieting carrier and you will see a flat line. If you see sine waves like that of Fig. 2b, this can be a low frequency MCW ID on a repeater or hum in a transmitter. Through Lissajous figures you can also try to determine the frequency of the audio signal. Its most important function, however, is to help locals to roughly set their deviation level. Again, a standard for calibrating your

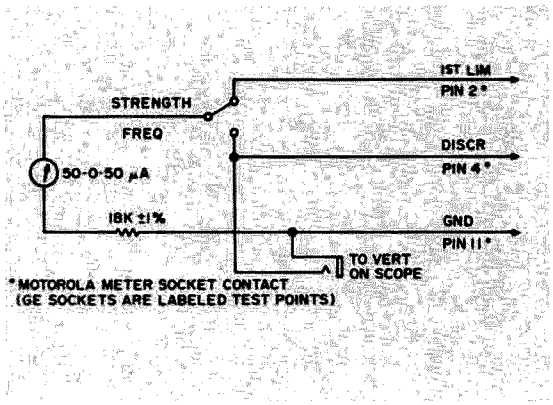


Fig. 1. A zero-centered, sensitive meter can be switched from discriminator to limiter test points to monitor frequency and signal strength. Scope output monitors discriminator continuously.

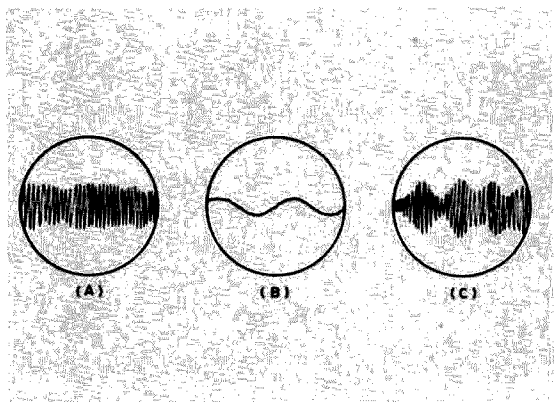


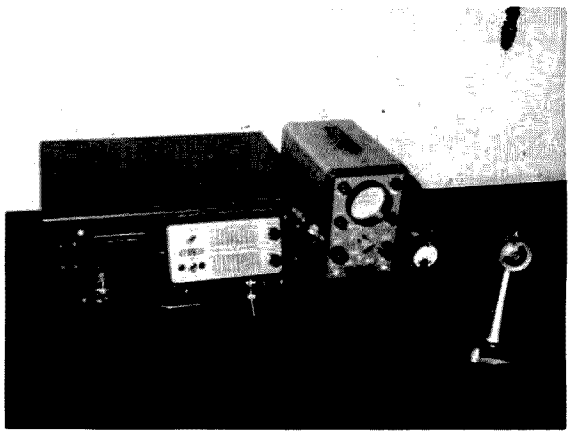
Fig. 2. Swept scope traces show discriminator noise (a), low-frequency products, such as PL, on a signal (b), and a fully modulated, strong signal (c).

scope could be a fully modulated repeater output signal. Knowing that a repeater has been set up for 12 kHz deviation, for example, you would adjust your vertical gain so that 12 kHz would read 3 cm (4 kHz/cm) on the CRT while a fully modulated signal is being received. It should be noted that by "fully modulated" we mean modulated to the deviation limits acceptable by the repeater. By approximation, you can estimate the unknown deviation being transmitted. A full-quieting signal with good modulation should look something like Fig. 2c.

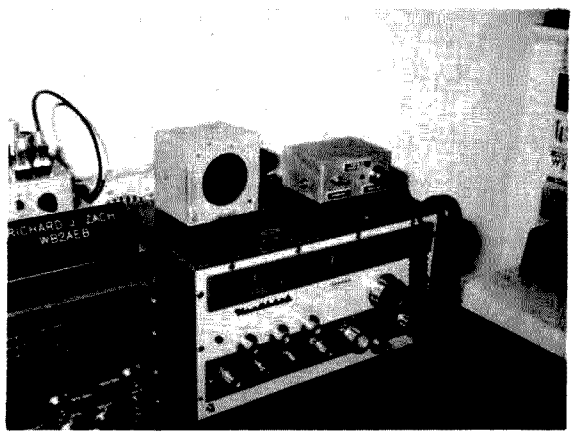
Another gadget which quite a few FM hams employ is a remote control unit. Many a non-FM ham at one time or another has thought of doing this, but abandoned the whole idea due to receiver drift and the need for many controls. To remote an FM rig by wire, it is simply a matter of bringing out the mike, PTT, and speaker leads. With Motorola and GE, this is a "no holes" modification if it can even be called a modification. I remoted my GE Progress Line through the microphone jack. The basic modification to the 4EC29A front-mount control head is to connect a 2.2 kΩ half-watt resistor from pin 4 on the microphone jack to pin 11 on P701.

As an optional convenience, install a small SPDT switch on the side of the control head. In case you want to hear only the remote speaker and not the local, this switch disconnects the local speaker and puts a resistor load across the output transformer. Since I had an abandoned rotor wire already going from the rig to the shack, I used that. The 100 ft length did not cause any loss or hum problems. The connections on the GE microphone jack are the following:

Pin 1 - mike low (grounded in transmitter), voice coil low
Pin 2 - mike high
Pin 3 - PTT high
Pin 4 - voice coil high
Socket - ground



The complete VHF–FM base station in use at WB2AEB. Note added muting switch on side of control head and external metering jacks.



The remote unit can be tucked into even the most crowded shack. Note remote speaker muting switch (quite handy).

To transmit, ground pin 3. To remote a Motorola rig, the procedure is the same but the leads can also be brought out from the power and metering jacks. (These might vary from rig to rig so consult a schematic for connections.) As you may have guessed, the squelch and channel selection must be made at the rig itself, but with work these can be remoted too.

In your own area, a special or unique feature might be in operation. Some groups have a system where when a special audio tone is received, an alarm is set off denoting a communications emergency. Other outfits have an automatic phone patch (called autopatch) built into their repeater. Many autopatch-equipped repeaters are now converting to Touchtone because of its versatility for dialing and control. As you can see, the needed accessories can vary widely.

Although not usually considered accessories, manuals, schematic digests, and other literature are vital to the FM ham. Since these rigs were designed for business usage,

EL 3401A/54

New Norelco Video Tape Recorder

AT A NEW LOW PRICE OF $585



This VTR will accept any composite video signal (random, 2:1 or EIA) fed from a single coaxial cable, TV camera, etc. These units are brand new, complete with head, and instruction manual in original factory cartons & use 1" tape. Original list price was in excess of $3000. Limited quantity – shipped by truck or REA, transportation charges collect, approx. wt. 100 lbs. Check with order only. $585 net. For additional information, request our free flyer 970J2.

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many different versions of the same rig can exist. Without a schematic digest, even the seasoned FM ham can get lost in a rig. Generally speaking, these manuals are of excellent quality and are quite reasonably priced. One such book is the *FM Schematic Digest* by Two-Way Radio Engineers, a 73 advertiser. This contains Motorola schematics, crystal information, pictures, block diagrams, FM theory lessons, alignment information, and more. The information contained is for older-vintage Motorola rigs. If your Motorola rig is a comparatively recent model, try writing to your local Motorola Parts Depot. There are six depots:

1170 Chess Drive	2333 Utah Ave.
San Mateo CA 94404	El Segundo CA 90245
415-349-3111	213-644-1101
1875 Greenleaf Ave.	3320 Belt Line Road
Elk Grove IL 60007	Dallas TX 75234
312-439-7150	214-241-2151
15-00 Pollitt Drive	Lake Mirror Road
Fair Lawn NJ 07410	Forest Park GA 30050
201-791-1700	810-751-3185

If you own a GE rig of the Pre-Prog era (1949 to 1955), General Electric has two books available which were written especially for the amateur. Volume I covers low-band (25 to 50 MHz) and mid-band (72 to 76 MHz) rigs. Containing information akin to the Motorola book, this publication has the GE number LBI-3883. Volume II (LBI-3884) has information on high-band (150 to 174 MHz) and UHF (405 to 475 MHz) rigs. Both books are $4.50 each and are obtainable directly from General Electric Company, Box 4197, Lynchburg VA 24502. If you want a Progress Line manual, it will cost less than $2 and is written for your specific rig. General Electric also publishes "Datafile" bulletins. These are excellent booklets on such topics as "Fundamentals of Solid-State Logic Circuits," "VHF and UHF Propagation," "Radio-Frequency Interference in Two-Way FM Radio," and others. I would heartily recommend getting Datafile Bulletin 10006-6, "I-F Alignment of Two-Way Radio FM Receivers." This book takes the "twiddling" out of the ticklish job of FM i-f alignment. Undercoupled, critically coupled, and overcoupled i-f filter alignment are discussed. Of the Datafile series, this is the most expensive volume, with a price tag of $1.50.

For a complete listing of all GE publications of interest to the ham, write for list ECP-227. It's free.

Howard Sams puts out the *Communications Equipment Schematic Manual.* This covers mostly late model transistorized rigs, and is divided into five sections: Basic Theory, FM Transmitters, Double Superheterodyne Receivers, Power Supplies, and Alignment Procedures. The $3.50 book is obtainable from your local radio store. For those of you who are getting serious about putting up a repeater, Ken Sessions (K6MVH), editor of 73, has written the *Radio Amateur's FM Repeater Handbook.*

Until recently there was also a magazine which specialized in FM operation (called *FM Journal.*). This magazine is no longer in business, but the editor and publisher have joined the 73 staff – a fact which should serve to keep this magazine in the forefront of the FM activity. ... WB2AEB ■

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HOW TO "MEGGER" YOUR ANTENNA

A simple, proven way to periodically check the performance of a transmission line/antenna system which can uncover faults not indicated by SWR measurements.

Meggering of antenna arrays and rf transmission lines is a procedure frequently performed by commercial and military activities during the construction or preventive maintenance cycles. It is rarely done by amateurs, and yet the procedure and equipment are relatively simple and the test can reveal a great deal about the condition of an installation. It is not a simple ohmmeter check as it may appear to be at first glance. This article explores what function a "megger" check accomplishes, how to perform the check, and the details of some equipment which can be used.

Insulation Resistance and Cable Quality

Rarely does any amateur have a station installation where the transmitter output (or receiver input) is directly wired to the antenna transmission line which, in turn, is directly wired to the antenna. More typically an installation will look somewhat like **Fig. 1** if one traces in detail the signal flow throughout. Obviously, a great many more connectors, switches, and accessory items are involved than is readily apparent. Also, in any real installation, the cabling goes through many bends, and outdoors, is exposed to a variety of environmental factors.

Most amateurs rely upon an swr meter to give them an indication of how the overall

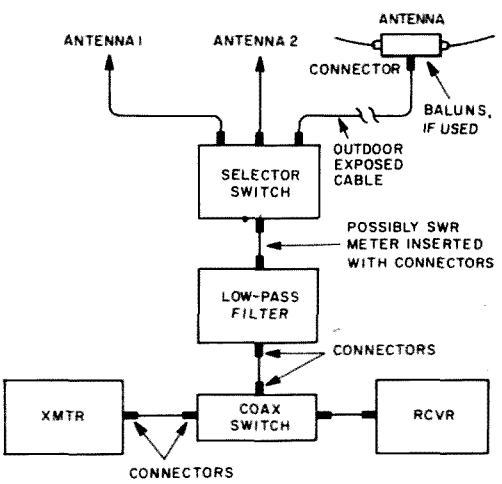


Fig. 1. Actual transmission path in usual installation can involve going through a number of connectors and accessory devices.

antenna system is performing and whether any damage to the system has taken place. On a day-to-day basis, the use of the swr meter for this purpose is probably valid. Ideally, one should also have a method for constantly checking the overall signal *attenuation* throughout the antenna system. It must be remembered that an swr meter, depending upon its method of operation, measures only the impedance ratio or current/voltage phase relationship in a transmission line. Attenuation can build up through cable deterioration, connector losses, leakage resistance, and component deterioration in accessory or switching devices—and this buildup will never be apparent on the swr meter reading. More than one amateur operator (and even quite a few professionals) have read a 1:1 swr at the transmitter and gone happily, but often unsuccessfully, operating when the swr at the antenna was quite high.

To measure attenuation correctly, one should inject a signal of known amplitude in the transmission line system and then measure the output at the terminated end of the system. Such a measurement is generally made when a commercial installation is initially put into operation, and it would be a good idea for amateurs to follow the same practice.

Unfortunately, such measurements are not convenient to make and one hardly wants to be continually faced with the problem of gaining access to the antenna end of the transmission line to connect a signal generator or terminated voltmeter to it. There is no simple in-line form of meter, such as a swr meter, which will check attenuation. The megohmmeter (or "megger" as it is incorrectly but commonly called), however, is commonly used to detect the change in insulation resistance in a transmission line system. Decreasing insulation resistance is a positive sign that leakage resistances and other dissipative effects are developing which can increase the attenuation in the system.

Megohmmeter Usage

The megohmmeter is simply connected between the two terminals of the transmission at the transmitter. The antenna end of the transmission line must not present a closed circle. This is no problem if a dipole antenna is used; nothing must be done; it is simply left connected. If a loop type of antenna is used, one of the two transmission line connections must be broken to effect an open dc loop.

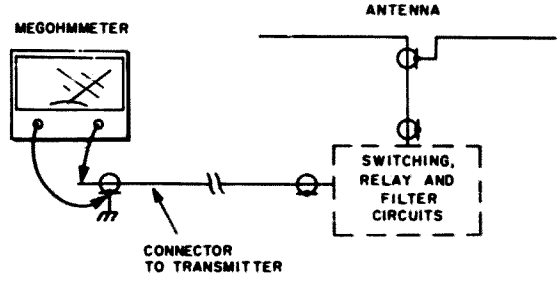


Fig. 2. Megohmmeter check is performed as simply as an ohmmeter check, but its meaning should not be confused with that of a simple ohmmeter check.

At first glance, the procedure used may seem to be that of a simple ohmmeter check (**Fig. 2**), and indeed that would be the case if an ohmmeter were used. The megohmmeter differs from an ohmmeter in several respects, although it is basically also a simple instrument. The maximum resistance range on the usual ohmmeter is a few megohms. The ohmmeter impresses a relatively low voltage across the resistance to be measured (perhaps 1-3V when used to measure a megohm). The megohmmeter, on the other hand, reads resistance ranges higher than 1 GΩ (1 gigohm, or 1000 megohms), and impresses a voltage across the circuit being tested equal to or above the voltage at which the circuit actually operates.

In practice, megohmmeters which place 50-500V across the output terminals are used to test rf transmission lines. Various leakage resistance effects can be present which will not be apparent unless at least such a value of voltage is used. No harm can usually be done using these voltage levels since even small cables such as RG-58/U are rated at 1.9 kV. However, one must also take into consideration the maximum voltage rating of the relays, filters, etc. present in the entire transmission line system. Usually, these voltage ratings will be found to be the

limiting factor, although rarely will they not allow the use of up to a 500V megohmmeter.

What insulation resistance or megohmmeter reading should a good transmission line system present? Ideally, one should "megger" a system when it is initially installed and when actual attenuation measurements are made. With a good dry system, insulation resistance readings of at least 100–200 MΩ should be possible. Then, if readings are taken periodically–monthly or whenever some problem is expected–one has a reference reading to compare subsequent readings against. If no attenuation readings are taken, the minimum insulation resistance which should be considered satisfactory is 50–100 MΩ. During wet weather or damp conditions, resistance readings may drop to the low end of this range. However, readings much below 50 MΩ or, especially, a continuing series of decreasing readings which are taken under similar conditions indicate that some component in the transmission line system is going bad or that some connections were poorly made and moisture is entering the line.

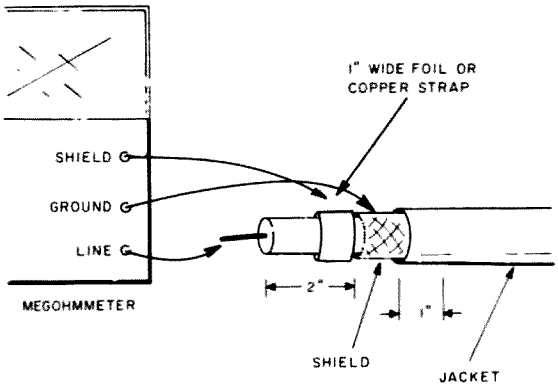
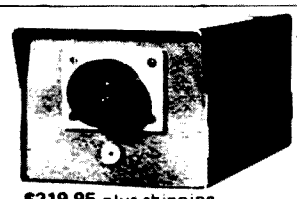


Fig. 3. Megohmmeter connections as set up for accurate insulation resistance measurement on coaxial cable. For most amateur purposes, shield connection is not necessary.

Megohmmeter Construction

A megohmmeter presents a potential of 50-500V across the circuit to be tested, but its internal resistance is in the order of megohms and little current flows in the circuit under test. Aside from this, a megohmmeter operates on the same principle as a regular ohmmeter.



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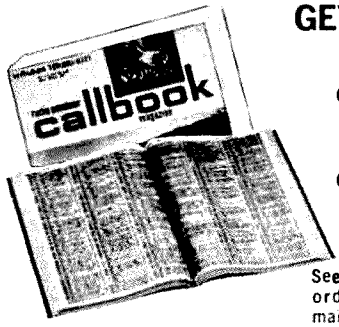
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There are both mechanical and electronic megohmmeters. The former type uses a hand crank to turn a dc generator and it incorporates a special differential meter movement. New instruments of this type are somewhat expensive but if one can be found on the surplus market, it would certainly prove to be a complete, self-contained test unit. Three terminals will be found on these instruments, labeled *ground, line,* and *shield,* as shown in **Fig. 3**. Normally, the ground connector is simply joined to the shield of a coaxial cable and the inner conductor of the cable to the "line" terminal. If, however, accurate readings *over* 100 MΩ are desired, a leakage shield must be placed around the cable end as shown. This shield is insulated from both conductors of the cable under test and connected to the *shield* terminal on the megohmmeter. It prevents surface leakage at the end of a cable that influences the taking of accurate readings above 100 MΩ.

Many forms of electronic megohmmeters are available and utilize ordinary meters rather than special differential types. One such megohmmeter, manufactured by Reiner Electronics (which also may be available on the surplus market), type CALN-60089, is schematically shown in Fig. 4. The circuit is relatively simple, the batteries make the unit portable, and the 50V test voltage level is suitable for most amateur needs.

A 67.5V battery supplies the current to the circuit under test into the grid of the amplifier tube. The meter responds to the total cathode current which flows in the tube. Since the tube is operated in a positive grid current region, the meter response to the current flow will follow a logarithmic response. Thus, the following meter readings in microamperes will correspond to the following resistance values: 0 μA to infinity, 3 μA to 10 GΩ, 20 μA to 1 GΩ, 27 μA to 100 MΩ, 50 μA to 10 MΩ, 70 μA to 1 MΩ and 100 μA to 0.0Ω.

Operation is simple: The ground and test terminals are shorted directly together and the *zero adjust* potentiometer is used to set the meter at 100 μA or 0Ω. The switch in series with the battery may be a pushbutton type if desired since the tube is an instant heating type. Other high-gain tubes may also be used but the meter scale will then require recalibration by using resistors of known value. The meter itself may be any conventional 100 μA type or even a similar range on an existing VOM. Some initial difficulty may be found in obtaining the one 500 MΩ resistor called for in the circuit. The resistor can be built up from a series group of lower value units, but ordinarily resistors up to 22 MΩ are available. With some diligence, however, resistors with values of 100-300 MΩ can be found, especially from the larger supply houses. Some suitable types are Aerovox CE500 series, Caddock MG780 series, and Dale MC-2 series.

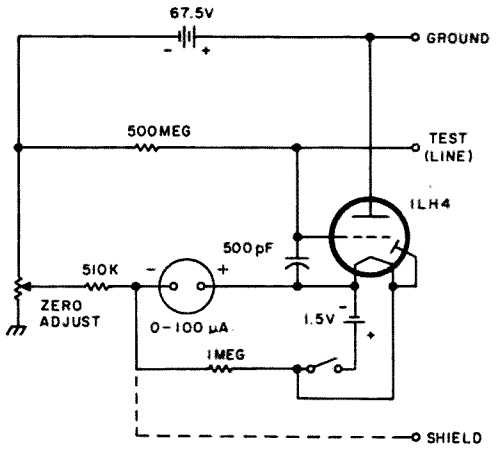


Fig. 4. Schematic of simple portable electronic megohmmeter which will measure up to 1 GΩ.

A *shield* terminal can be brought out, if desired, from the negative meter terminal as shown in **Fig. 4**. As explained before, however, such a connection only has value if one wants accurate readings above 100 MΩ. Generally, relative readings and particularly noting their change as periodic tests are performed will suffice. If the unit is constructed in a metal enclosure, the *test* terminal must be a good quality feedthrough; otherwise its leakage resistance will parallel that of the circuit being tested. A Teflon insulator is preferred.

Lastly, one should never hold the test prods, if such are used, across the circuit tested; they should be clipped on. Not only is this a safety precaution, but body resistance can drastically affect readings when one is performing measurements in the high-megohm range.

. . . W2EEY/1■

LETTERS

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bunch of rocks [illegible] n
you ignored my comments in
I insist that you print ev
should be boiled in oil ov

Toned Repeaters

I enjoyed the article *Encoding and Decoding in FM Repeaters* in the February issue of 73. In areas with overlapping coverage from one or more repeaters some sort of tone coding certainly would be desirable, but I fear we might end up with incompatible systems if we don't agree on some master tone system soon. What good are repeater crystals without the proper entry tones?

Touchtone is certainly going to become even more of a standard than it is today. Why not use the four tones from the Touchtone high group for tone-burst systems. Anybody traveling from area to area would then need only his Touchtone pad rather than an audio VFO!

For your repeater list the only machine operating in the greater Vancouver area is VE7ACS 146.34 to 146.94.

Darrell Wick WB6MAY/VE7
President B.C. F.M.
Communications Assoc.

There should be standards for Touchtone as well as tone-burst entry. The TBE standards are already reasonably well established. See, for example, "A Look at Amateur FM Standards," by Robert Kelty WB6DJT, 73 Magazine, March 1970.

I have written a letter to Robert Booth, Jr. of ARRL, as follows:

> "Please be advised that I am not a member of the ARRL for specific reasons. Consequently, I wish to specifically point out that any inference that I am represented by the ARRL in petitions to the FCC for rule changes is not in order.
>
> "I believe it would be appropriate for the ARRL to specify the number of LICENSED MEMBERS represented by the ARRL in each petition tendered to the FCC."

This was brought about by the latest idiocy of the ARRL, to open all of the 2 meter band to the Technician, as well as a part of the 10 meter band. What kind of thinking is this? Incentive licensing to upgrade the amateur and now a program to reverse the process and made even the General license of reduced value. Looks like the ARRL circulation has fallen off badly.

Of course I have written to the FCC to this latest ARRL petition, but the way things have been railroaded I suppose it is too late to do anything about it.

I have pointed out to the FCC that petitions presented by ARRL should specify the current number of licensed members represented by them. The number should not include libraries, business corporations, SWL and other clients who do not have an interest in the matter.

William J. LaHiff W2IVT

Death of a Friend

I have a homebrew linear amplifier that runs 3 kV on the plates of the finals. Last night I left the back cabinet door open to make a bias adjustment. What I didn't know was that the contacts on the plate supply relay welded shut. About an hour before I came down to adjust the 80 meter tank, I heard a tremendous commotion downstairs. My father ran down, saw my rig smoking and popping horribly. He ran into the utility room and popped the 220 breaker to the B+ supply. I ran to the linear, looked inside, and saw my cat splattered all over the inside of the cabinet. The whole house was pervaded with a sickening smell for days. That cat looked like she had been napalmed; she was really roasted. It took three hours of nauseating work to clean the rig out. Burnt hair and flesh don't clean off well.

What would have happened if I had grabbed the plate caps working on the rig? A quick word: *Don't* use a toggle switch to control the plate supply! Use interlocks! Use some kind of high voltage indicator!

With several thousand volts, *you don't get a second chance!*

A Sorry W9

Apollo 12 Special Certificate

Here is a copy of the Apollo 12 special certificate which our club station is issuing to all amateur stations contacted during launch day. A total of 1285 QSOs were made on the 80, 40, 20 and 15 meter bands. Seven transmitters were utilized in the CW and SSB modes.

Our club station is located approximately 10 miles south of the Apollo launch pad. This affords us an excellent view of the liftoff. Transmissions from the club station start shortly thereafter. This activity started with the launch of Apollo 7 and we have mailed out thousands of similar certificates. It is the club's way of sharing with other "hams" the events of that day.

Operators at this station consist of NASA, Air Force, and contractor personnel. This station is often activated on weekends and can be found at approximately 21.340 MHz.

Roy J. Durso K4DJN/W2KTG
Box 21073
Kennedy Space Center FL

Advanced Class Course

I want to add my thanks to you for the excellent series of articles you have had in the past two years on advanced radio theory. I got started in ham radio as a Novice with my high-school age son in January 1967. In December 1968, having studied your articles, I made the Advanced. Last December I passed the Extra.

With your articles, anyone can pass the theory for these higher class licenses. They not only will get a better (?) license, but they will know theory that they can apply in the fascinating aspect of building and repairing ham gear.

In addition to using your articles for the license exams, I have used them as a basic text for the course in advanced theory I have been teaching for our radio club.

The higher code speed came easy through my activity in the Army MARS program. Once again, thanks!

Bob Malmquist WA9TTS
605 Vine Street
Morris IL

The Truth Hurts

Once again 73 magazine has set a new standard for an amateur oriented magazine: truth in advertising!!! I refer to the "30 Back Issue Bonanza." When you said the issues were packed in sloppy bundles, you certainly weren't fooling! I got my bundle today, the box was split down the seams, and wrapped in old bailing wire. The box (?) was also marked "Received Damaged–Kansas City, Mo." I have received numerous packages that have been promised to arrive in good condition and haven't–but this is the first time I have been told to expect a bundle in bad condition. 73, I salute you for truth in advertising! By the way, I think the mags. are great. They're worth their weight in gold!

Russ Williams WA6MWY
1312 Lawrence St.
El Cerrito CA

A Political Approach

Have you listened to the 7200–7300 kHz area of the forty meter band lately at about 0300 or 0400Z, especially on a weekend? It has become an international shortwave broadcast band at times in the evening hours.

Allow me to introduce myself. I'm one of those terrible young whippersnappers who think they know everything. Seriously, I'm 16 years old and fed up with that mess on the upper end of the 7 MHz band. It has fewer and fewer amateurs and more and more broadcasters almost every week, which is no way to run an airline, or to convince the next ITU conference on allocations that we really need those frequencies either.

It is rapidly becoming apparent that the ARRL Intruder Watch, while it proved that these schnooks were beaming at the U.S. and lying through their collective teeth when they said they weren't, did next to or absolutely nothing towards convincing officials to do anything about it. Doubtless most officials have forgotten about it (albeit with effort) to take some decisive action towards getting a few bureaucratic types to stand up and maybe even do something, for the first time in their lives. Decisive action must be taken if we are to be able to really use this part of the forty meter band.

Political action has more effect on government-involved people (including FCC and the international organization known as International Telegraphy Union) than any other kind. And of the most effective of political action is to indulge in the freedom of the individual in this country, which, if I may add, happens to be the best on this earth, bar none. This method is simply *writing.* If every other amateur in the country wrote ITU and FCC, each would receive about 150,000 letters. Imagine the impact of that! Or write Barry Goldwater. He would appreciate the situation, being a ham.

But a massive write-in program needs publicity. So, why don't 73, CQ, Ham Radio, and QST publicize it? No reason against it at all. In fact, Mr. Green, if you used "de W2NSD" and Mr. Huntoon used his editorial column, a great deal of publicity could be obtained, as both columns are controversial and tend to be widely read.

An all-out effort by all these magazines providing a united front of amateur radio to the world, and a vast write-in campaign such as I suggested would lend quite a bit to the appearance of amateur radio in the world. It certainly would promote a lot more respect of amateur radio. And isn't it simply for a lack of respect for the amateur bands that these broadcasters can do this?

Mark Hinton WA3IVW
2404 Stratton Drive
Rockville MD

CB vs Hams

As I'm writing this letter, several people are out in the damp, foggy night and are hunting for a three year old boy. It is 1:30 a.m. The child has been missing since 4 p.m. yesterday. The following is an actual account of what happened only a few hours ago.

As you can see from this letterhead, I attend Lehigh University in Bethlehem, Pa. I was studying calculus (we all don't get drunk on Saturday night) when one of my schoolmates knocked on my door and asked me if I knew where the Lehigh Valley Shopping Center is. He told me that a three-year-old had been lost there, and he and another fellow were going to see if they could be of any assistance to the search party. I volunteered to go with them.

Since we were all strangers in town, we had to call the police to determine where the shopping center is (we all don't hate cops, either). It turned out to be four miles away, and since we couldn't find anyone with a car, we decided to walk.

After about an hour and a half, we reached the shopping center. The first thing I noticed was the abundance of CBers. The CB–ham rivalry never actually hit me because I was concerned with the child's being lost.

The police had just finished searching the department store the child was last seen in and they gave out the general areas to be searched. Our group took one area and we combed several square blocks. About 1 o'clock the walking search was given up. All the area within a 1½ mile radius of the shopping center was searched with no luck, so the search was to be resumed at dawn.

Since it was past one in the morning, and we had a four-mile walk back to the dorm, we bummed a ride with someone high up in the CAP. While riding back, the CAP official made use of his radio, a converted CB rig.

I can't help thinking that if there had been better organization, the child would have been found. There was no radio communication with the majority of walking groups. The CAP seemed to have the most effective communications. The only other groups were the police and CB. If someone could have coordinated these different services there would have been a good chance of finding the child.

By now you are probably wondering what role ham radio played in this. As far as I can tell, there were no hams present. What good does all that operating skill do with no hams there to use it? The ham magazines print plenty of stories telling how hams help in emergencies. What about his instance?

What I am proposing is two different types of emergency nets. The first is a long distance net on or near 20 meters (I say near because the FCC might give us a few channels above 14.5 MHz if we can prove we have an effective emergency system). The second would be a local net in the 10 meter band. This net would provide mobile and most especially portable equipment,

which is converted CB equipment. Let's face it, ham radio is lacking in the portable equipment area.

Both nets would incorporate tone signal alert type equipment. Both systems would use crystal control or at least be fixed. The clincher; the frequencies would be kept clear at all times (now you know why I said *near* 20 meters).

I'm not proposing these measures for the betterment of amateur radio–I'm merely stating that I think it should come up to what is morally obligated to do, and then worry about contests, ragchewing, DX and all the fun.

Anthony A. Parise WA3HRL

VHF FM appears to be solving the problems you mention. It has three things going for it: availability of equipment, portability of equipment, and fully channelized operation.–Ed.

Credits

In your February editorial you stated that the Department of Communications used the Buffalo petition as a foundation for Canadian repeater regulations. This is not true, and you gave Buffalo all the credit, completely ignoring the fact that it was the Toronto FM Communications Association, especially Paul Hudson, VE3CWA, who drew up a brief, using some of the information in the Buffalo petition, and submitted it through the Radio Society of Ontario and the Canadian Amateur Radio Federation to the D.O.C. in the spring of 1969.

To back up my statements, I have enclosed a reprint from the November 1969 issue of the Ontario Amateur, which is the publication of the R.S.O.

I hope that your statements will be corrected in the next editorial.

Jim McCullough VE3CSO
Treas., Toronto FM
Communications Assoc.

Neglecting the contributions of the Toronto group – and particularly the efforts of Paul Hudson – was my error. I knew that Paul had formulated the original petition, but I also knew that he did it in conjunction with Gil Boelke, and the work was based on the already-submitted Buffalo petition. Just so you will know my position, Paul Hudson is one of my dearest friends, and he is the one who informed me of the petition's formulation, as far back as January of 1969. He spent a few days with my family in California at the time and gave me a complete rundown on what was happening in Canada. (See **Mr. Virgo Himself**, *this issue.)*

Servicing SSB

Re Boos and Hisses (February 73): I am glad to see you print the pros and cons of the issue.

As one who has been a ham for years but due to lack of time, money and energy trying to keep up with a trade and raise a family, I was not able to keep up with the state of the art in ham radio as I would like to have done (namely single sideband).

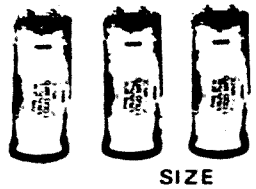
W4NVK's article in December 73 and WA8ASQ's letter are thought-provoking to say the least and will make the study of this stick in my mind better than anything else could.

I think WA8ASQ was entitled to the $35 charge to fix this man's equipment, since he has

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14,000 MFD- 13 VDC	2" x4½"
15,000 MFD- 12 VDC	2" x4½"
15,500 MFD- 10 VDC	2" x4½"
15,000 MFD- 10 VDC	2" x4½"
25,000 MFD- 6 VDC	2" x4½"
30,000 MFD- 10 VDC	3" x4½"
60,000 MFD- 5 VDC	3" x4½"
20,000 MFD- 15 VDC	2½" x4½"
15,000 MFD- 15 VDC	2½" x4½"
35,000 MFD- 12 VDC	2" x 6"
7,000 MFD- 13 VDC	1 3/4" x4½"
3,000 MFD- 25 VDC	1 3/4" x4½"
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3,750 MFD- 75 VDC	2" x4½"

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the ability to do the job and spent his hard earned money for all those goodies of test equipment. After all, maybe some of these fellows who can't fix their own gear are experts in some other field, and when WA8ASQ calls for their services, things will swap back.

Orville Gulseth W5PGG
1435 King St.
Clarksdale MS

English Spoken, American Understood

In 73s new feature "DX Corner", K2AGZ, said that German, Czech or Russian Amateurs speak such good English, and comments that American Amateurs sometimes speak poor English, and finds this "downright humiliating".

To a Englishman this is a somewhat surprising statement, not that he has not observed this phenomenon, but rather that the British always imagined that the differences between the language spoken in the United Kingdom and that spoken by some Americans was deliberate on the part of the Americans. A deliberate gesture of independence, a deliberate decision to speak differently from the British, and this does not refer to accent, but to the use of words.

This deliberate difference shows in several ways if you listen on the air. There are those who are deliberately so careless, or appear to wish to give the impression of a slovenliness in their speech which makes one feel that they are saying "we aren't going to take the trouble to stick to all the silly rules that an old-fashioned grammar once laid down. We are going to speak just as the words come into our mouths and be modern."

This is particularly noticeable in the use of the adjective where an Englishman would automatically use the adverb. "Your antenna is working real good" whereas the Englishman would say – "Your antenna is working really well". The use of "good" whereas we should use "well" is a typical example.

But another and much more interesting school of thought uses additional words which the British omit. Thus an American "visits with a friend" whereas an Englishman "visits a friend."

To an Englishman the verb "to visit" is a transitive verb which is followed immediately by the object. It can also be an intransitive verb. But why complicate the issue? Since it is transitive we just "visit people" and see no need to add the extra word "with".

If an Englishman visited George yesterday, he would say "I visited George yesterday". The insertion of the word "with" would only be used if he were accompanied by someone else. Thus – "I visited George yesterday". "Were you alone?". "No, I visited him with Mary", meaning that he and Mary visited George yesterday.

Another example is the expression "For free". If an Englishman finds he can get something without paying for it, he says he "got it free". The American finds it necessary to add the word "for" before free and he says "I got it for free"

Originally, one imagines the addition of the word "for" was a joke, intended to lead the listener to expect a price after the word "for". Thus the listener could expect "I got it for five dollars", and he is suddenly surprised to find that no price follows the word "for". But what may have begun as a joke or a method of emphasis has by now become part of the language.

What is perhaps surprising is that the American language frequently adds extra words. Surprising because the Americans pride themselves on a slick and snappy language. There is the occasional short snappy phrase such as "at" at the end of a transmission instead of "over" – one syllable instead of two. But, in general, the American language becomes longer. What to an Englishman is a "Lift" is an "Elevator to an American. What to an Englishman was a "tram", was a "trolley-car" to an American.

Another and, of course, well known phenomenon is the use in America of words and phrases which were used in England several centuries ago but have died out in England. They are still in common usage in America and are then often re-adopted several centuries later again in England. The classic example is, of course, the Englishman says – I've got a cold". The American often says – "I've gotten a cold". "Gotten" was current usage in England in the 17th century, but it has died out now. The American may even say – "I've gotten me a cold", adding the extra word as in "visiting with" or "for free"

Edgar Wagner G3BID
London, England

Ban the Book

I have been receiving 73 for several years and generally appreciate the articles. I know that you are always interested in reader opinion, so I am sending this belated note to give my reactions to an article you carried last fall. Due to my schedule, I was only able to jot a note to myself to write when I have time.

In the October 1969 issue of 73, on page 34, you have an article written by Robert Manning, K1YSD. I believe this person writes some technical articles quite frequently. This article, "Vidiots That Have Known Me." was quite shocking in its vulgar language and its general low caliber of thought. I feel that it was entirely out of place in your otherwise fine magazine.

I am not the type to hastily drop my subscription, but I would request that you please exercise more care in the selection of manuscripts in the future. I realize that humorous stories liven up a technical magazine, and I appreciate them, but please, let's keep it clean and above the belt. Thanks.

Jim Wagner
Brecksville OH

RM-1429

How about spreading the word about my proposed rulemaking RM-1429 before the FCC which, in essence, asks for authorization to use F4 (FM Facsimile) emission on the 2 meter band. I understand that the proposal is still under consideration by the FCC (at least the FCC hasn't denied it yet). Any and all interested parties should write to the FCC using acceptable FCC form, i.e. 8½ x 11 plain paper, typed double spaced, 1½" left hand margin, 1 original and 14 copies, etc., and offer their comments. In this way, I feel, sufficient interest shown by the amateur population will help stir the Commission to act on the proposal.

Jim Turrin WA8DCE/N0PCF
PO Box 245
New Philadelphia OH

The Buck

Having two days ago jumped from Tech to Advanced I decided it apropos to subscribe to a ham mag, and being familiar with the dynamic duo (Ken and Mike), I bought a copy of 73 (although I was floored by the $1 price). I have found it not only interesting and educational, but the projects are all of the type the "modern" ham would enjoy; what more can one ask for – ICs, FM, apartment dweller antennas, and an RTTY article far surpassing any I have read previously.

Congratulations to Dave Mann and his "Leaky Lines." The article was superb. Among other things, the ARRL has had their comeuppance coming for a long time.

Thus enclosed is a check for $12 for a three-year subscription. I have to get back and finish reading the issue. A very deserving "well done" to you all!

Stephen W. Gundlach WA3DJH
State College PA

I would like to say first of all that I have found 73 mag at the top of the list. But that's not what I'm writing about. I have had my Novice ticket for six months and am planning to get my General soon; and to tell you the truth, I can't wait to get out of the Novice bands. Ham radio is supposed to be the hobby of friendship. Well, not in the Novice bands. On 40 meters you get chewed alive by higher powered rigs of General and Advanced class ops. On 15 meters the chances of being chewed alive are a lot less, but what about those Novices who leech off you. I mean Novice ops that have other rocks but would rather try to get that weak piece of DX from you, rather than move to another rock or stand by.

If ham radio is to be the hobby of friendship, why not show it.

Robert S. Damrou WN1LOT
Clinton CT

You can tell the guys who have a hard time reading code, like for instance HC2RP. If those fellows spent the same amount of time studying the code as they do thinking up excuses on why we don't need it, they would have it down pat in no time at all. I am sure HC2RP would be copying CW and enjoying it if he took the same time and effort learning the code as he spent composing that almost one page letter. Mr. Romo, I am no genius, but I learned the code almost 50 years ago and I still enjoy pounding brass. Incidentally, I also work SSB and enjoy it also. Cheer up, Edgar, knuckle down and practice and you could be copying CW along with the best.

T.E. Burmeister W8BSS
Cleveland OH

If Jefferson and his peers had spent the same amount of time paying taxes to England as they did thinking up excuses on why we didn't need it, we'd still have a queen.

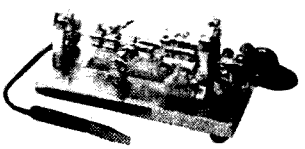
Thanks for a really fine ham magazine.

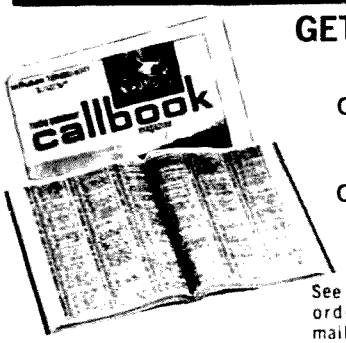
Looking through January edition which just arrived here, I find an editor's note referring to Radio Amateur's FM Repeater Handbook." Checking with the biggest local booksellers I found that they will not obtain a copy for me.

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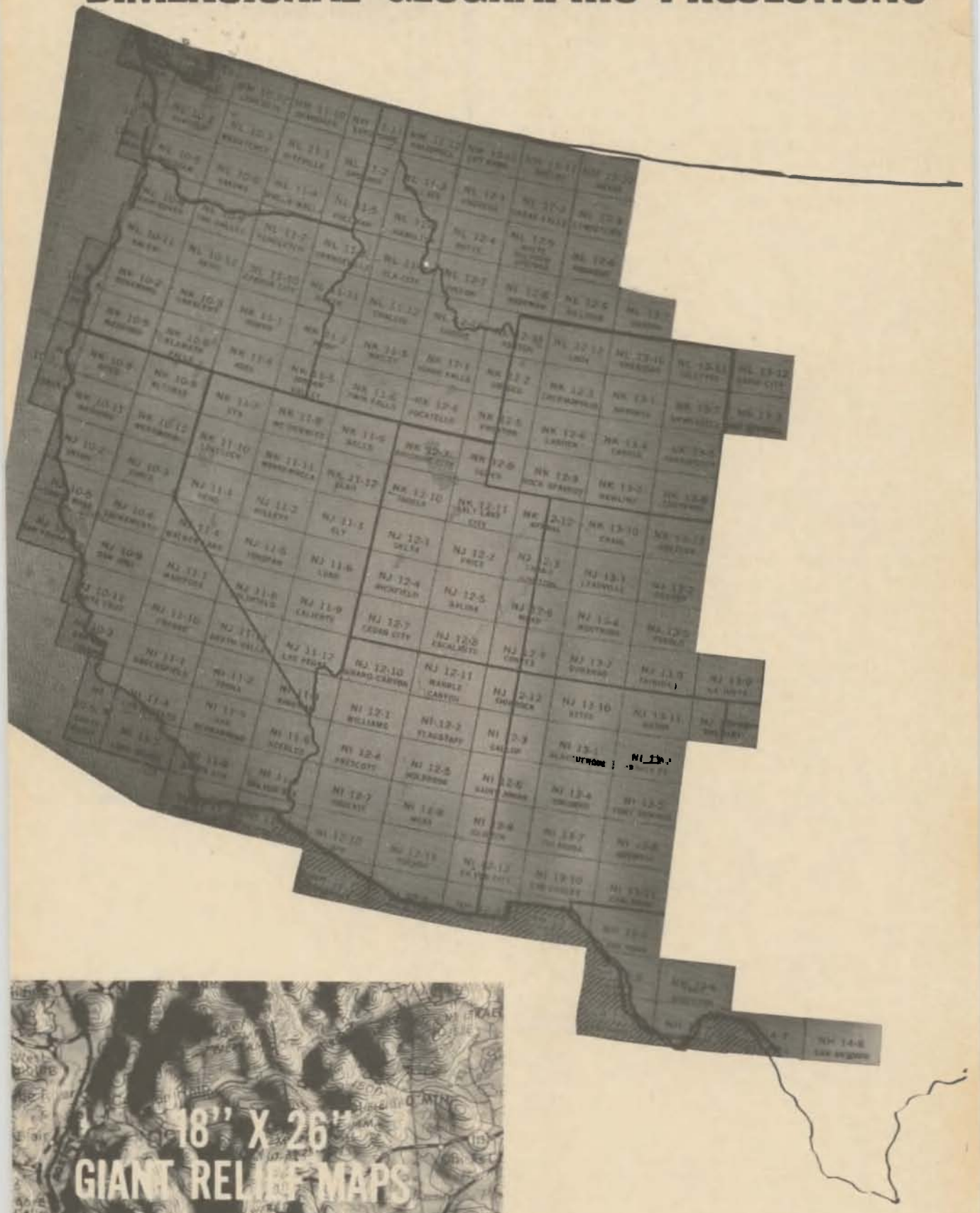
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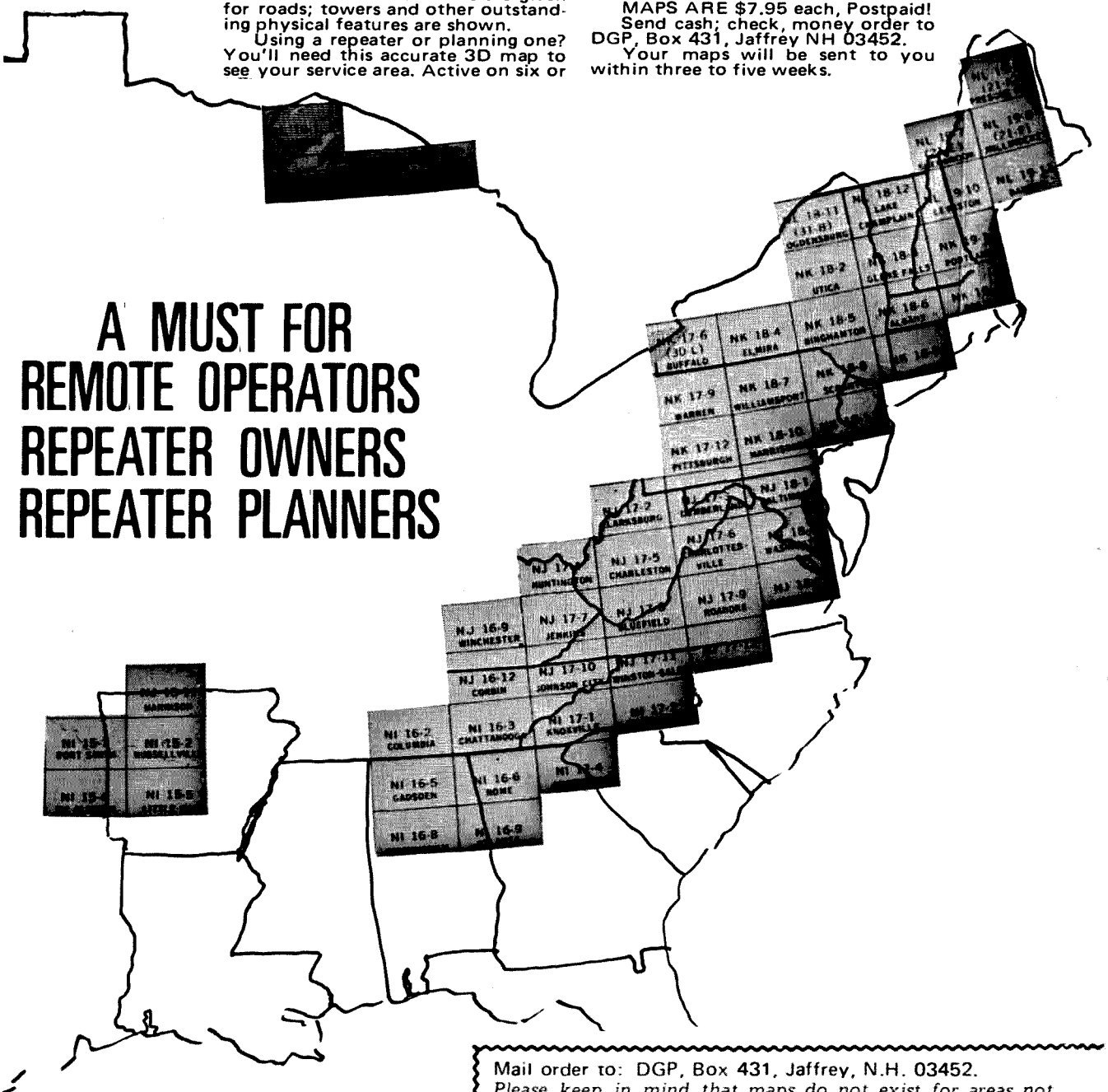
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I would appreciate more information regarding the cost and address of the publisher, so that I can send for a copy direct.

For information, here in VK4 there is quite a good deal of activity on 2 meters FM, in keeping with the rest of VK.

For simplex work three national channels are 146.146 MHz, 146.00 MHz, 145.854 MHz.

There are also agreements on frequencies to be allocated to repeaters.

ch 1	146.1 in	145.6 out
2	146.2 in	145.7 out
3	146.3 in	145.8 out
4	146.4 in	145.9 out

The equipment in use is predominantly surplus gear from the commercial mobile bands 148–174 MHz and 72–85 MHz.

John Edwards VK4IE
Queensland Australia

FM Repeater Handbook available from Editors and Engineers, Ltd., New Augusta, Indiana 46268. Price is $6.95 ppd.

Author Talkback

This reply will try to straighten out much of the misconception WA8ASQ read into the Carrier Suppression article on Pg 22, Dec issue, as obvious from his comments in "Boos & Hisses" letter, Pg 12, Feb issue.

First, I find it most interesting that this repairman makes his bucks fixing amateur gear. The fact that he charged a fellow ham 35 bucks to adjust his carrier suppression to a below 40 dB level tells me a lot more about the kind of operation he must run than does his whole letter, which reveals an awful lot. For analogy, the $35 represents at least 10% of the new cost of a transceiver. For analogy, this simple procedure is about as difficult as adjusting the headlight aiming of an auto. Can you visualize a bill for 10% of the car value, $3000 for aiming the headlights? While I can't claim such prodigious credentials as "repairman," I am a registered electronic engineer that did design some of the latest tactical communications systems for Vietnam, so maybe we can talk OK.

Seriously, though, most anyone can tinker a set into tremendous carrier suppression on the bench. My article didn't say this couldn't be done; it said that a very good set will *consistently* have carrier suppression of only about 40 dB. Take one of his tinkered specials into an environmental chamber, vary temperature, voltage, and bang it about some, and see where his carefully nurtured 60 dB ends up. Or, just let the rig cycle in a typical ham shack for a few months; same end result.

The comments about final bias and carrier leakage are a severe case of not reading what is written. Please reread the actual article, with bias filters removed OM.

The $2 mike mentioned works as claimed. I suffer no problems of receiver alignment as I used a rather elaborate audio frequency spectrum analyzer to show the actual spectrum coming out of the transmitter with expensive mikes and others, to find there is no discernible difference, in fact, after passage through a 2 kHz SSB filter. What I said may make a guy that peddles expensive mikes to unwitting SSB set owners unhappy, but facts seldom make merchants happy.

The article makes no claim that 200 PEP is equal to 100 CW, although this interpretation by the critic is not so farfetched as his other comments. My apologies for condensing the writing so much that this lumping occurred to insinuate these two are equal. Actually PEP has no real universally accepted meaning except when using a two-tone test and as a rating on equipment. Even then it means little since the distortion limits on ham gear are never mentioned. Raise the distortion limits you are willing to permit, and you can raise the PEP rating of any rig. However, since Mr. Kirsch is interested in edification, let me proceed. I have a linear that deliberately uses very unregulated voltage on the plates to give a form of audio compression. The absolute maximum the power supply puts out on CW is 900 watts input. However, on voice peaks, it puts out well over 2000 PEP, and this sounds fine because the collapse rate of the input DC voltage is about the same as the rate of compression allowable in successful audio compressors. This of course is a design of my own, which takes advantage of the characteristics of voice waveform compared to sine waves.

I'm sorry that my factual and practical article may steer some Novice hams away from Mr. Kirsch's $4000 repair bench, but that's life. I can understand his position, but that doesn't make me forgive him. Incidentally, a single spectrum analyzer adequate to measure SSB spectrums costs about $5000, so his bench does not awe me. I'll pass, but say that any ham that worries over a carrier suppression that is only 40 dB down is either a Novice or he's playing around, and has little better to occupy his time.

E. Dusina W4NVK

On QRM and Passing Exams

Frequently I cannot agree with some of your "advanced" thinking; but I am only an ordinary person. However, your excellent suggestion to use some brain power and go "where the QRM isn't" seems like excellent common sense. Like any brilliant idea, it makes the rest of us wonder why we didn't think of that instead of just growling at the ills of the ham world.

Your magazine's excellent articles on taking the higher class license, case history and cure for common TVI and audio TVI help ham radio. If only the growlers would put their energies to building themselves up rather than howling at the moon, how much faster we hams would progress in all phases. I was always zero in math and had nothing to do with electronics but when the rules of the game were changed I studied, boned up on the CW, and got the Extra. CW may be a "dead science" but it is a good mental discipline and test which any serious ham can pass. In fact, it is about the only practical "barrier" to the Memory Experts who know nothing about ham radio but memorize the Q and A, pass the nominal CW speed, buy a packaged station, and get on the air as legalized "diddlers." For those who feel the ham rules are unfair, there is always CB or tiddledy winks.

Keep throwing "out the sparks" even tho we may throw water at you!

K.A. Fichthorn W1FK
Southington CT

In the February 1970 issue, page 10-Letters-TVI Case-Daniel G. Willis, SSgt. USAF wrote an inquiring letter about Grid W4GJO's TVI suit. There are without any doubt many hams and others interested in the status of this most interesting case. Your answer was brief and incomplete. Do you know how this case stands at present? Your issue was scanned but no other article was found referring to this case.

The case has been dropped, but Grid is holding the bag for a good many hundreds of dollars due to the lawyers for preparative information to defend him. This kind of a lawsuit could be filed against any of us with the present condition of the laws.

Grid needs or could use the help of all those interested; first, to balance the present account, and second, to build up a condition where others will be protected from some crank.

We heard a pretty complete report by Grid at the Sarasota Amateur Radio Association meeting on January 20th. Grid will accept any contributions from individuals, publications, and manufacturers. The amount received over that necessary to pay the lawyers will be placed in escrow to cover expenses for their future plans.

This much information should be published and any further information can be furnished by Grid himself. His address is The Ham Shack, 1966 Hillview St., Sarasota, Florida 33579.

A. Howard Ettinger WN4NJJ
Sarasota FL

Thanks for keeping us posted. 73 wants to know all the details of all such lawsuits. The more they're publicized, the easier help will be to come by.

Just finished reading the February issue of 73 for the umteenth time and I must say you sure can put a lot of printed material in such a small magazine. I am in the hospital and have all the time to read that I want and I have learned a lot.

I would like to state my thoughts on the incentive licensing. I am not in favor of it at all. There are many operators who are physically handicapped as I am and amateur radio is a grand hobby to be interested in to help one relax. Due to my physical condition I am unable to go and take an examination for a higher class of a license. I don't think it is fair to take so much away from those of us who are unable to get a better license. I have listened on all the bands and there is a clear shot without QRM on those "special people" bands and where us ordinary folk get crowded in together and have a rough time. Dayton OH

Samuel F. Warnock K8NLM
Dayton OH

Re: Jan. 1970 Issue

After reading "Fascinating Fundamentals: Volta and His Piles" (ZAP), I am naturally looking forward to your next article which, surely, will be entitled "How to make your own Atomic Bomb – right in your own back-yard." (ZAP!)

I am sure that if your science editor had reviewed the ms before passing it, he would have made two recommendations: (1) Be sure that your friendly gas man sells you a battery mixture and not a jar filled with sulfuric acid and (2) he

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would have recommended the purchase of hydrometer (which the friendly gas man also sells).

I think also that your science editor should have inserted the following precautionary note: The author mentions both "a battery-mix" and sulfuric acid in the same breath. He undoubtedly means a diluted solution of distilled water and the acid which can be checked as to its specific gravity with the hydrometer, which should read: 1.84 for a proper mixture. Also: Concentrated sulfuric acid should be mixed with water by pouring the acids *slowly into the water.* Never pour the water into the concentrated acid as a large quantity of heat will be liberated. The acid may thus splatter and be dangerous. Please remember this when you issue the article on the making of the bomb; Some simple precautions must also be taken because the bomb could also splatter and become dangerous.

D. Alexander

Probably the only reason our science editor didn't take care of all these details is because we ain't got no science editor.

Rape of Frequencies

I have always been in line with your thinking, but your latest promulgation (do away with all sub-bands) I consider preposterous! You're the guy that supposedly rebels at the mere mention of being *forced* to do something, and then you come forth with this. I would rather imagine the appliance operators would be real pleased! You speak as though all hams are situated as yourself—with all kinds of ultramodern, very expensive equipment, which perhaps can cope with a chaotic condition. But think of the ordinary ham with ordinary equipment. Where does it leave him, were this to come about? Strikes me you're advocating a wrong course. I never see anything advocated in getting whole segments of unused frequencies occupied. Appears to me that Johnny Q. Ham is an ornery critter, squawking very vociferously only after something drastic happens. I never hear anything above the first hundred kHz on 10 or 20 cw, and the top 3 MHz on 6 are pretty barren. And the rape of 40 meters is pretty disgusting. Back in the 5 meter days I had a rig on approx. 59.8 MHz because everyone seemed to hug 56 MHz. I had no trouble making contacts. How many rigs will be found on, say, 53.8 MHz? CW on 2 way up on the tip is just a joke (another example of brainy planning?). Let's not compound a bad situation.

Iver Paulsen W1OL
Woburn MA

If you look again at 6, you'll find considerable activity above 52 MHz. 52.525, 53.68, and others have become national FM channels.—Ed.

The Toilet Float Revisited

I enjoyed W3KNG's article "The 20 meter DX copper ball antenna" on page 40 of the January 1970 issue.

I have found the answer to his toilet float problem and also, by the way, solved many others at the same time.

The people that copper plate baby shoes can copper plate the new plastic floats. Of course,

when you buy the plastic float you must ask for a low-loss type (perhaps Teflon?). If the 32 ft counterpoise is replaced with a mobile whip with a 40 meter resonator on it, it will still be an electrical 32 ft but much more convenient in size. Finally, if the entire shebang is water-proofed with plastic sandwich wrap, everything can be left in its normal place, which doesn't disable the facilities.

This takes care of people with a General or higher class license, but what about us poor Novices? I'm an 80 meter man myself, I was thinking about having the baby shoe people copper plate the entire toilet but my folks are becoming very down on amateur radio. Perhaps with your greater facilities you could carry the ball (no pun) and develop this idea to its full potential. Maybe you could develop a band-switching version of this antenna.

Clifford Major WN2KDO
599 Foch Boulevard
Williston Park NJ

Massive write-in campaigns have been flops in the past in every instance that I can remember. About the only event that has brought out the vote, so to speak, was the incentive licensing proposal, and that mass of letters was entirely ignored by the FCC.

There are things that can be done to help get that mass of QRM off 40m, and I have written of them in my past editorials. Since deliberate interference to the offending broadcast stations is illegal, it is difficult to come out strongly in favor of this in an editorial. This might have an effect. A more likely attack on the problem would be through the tourist department. If the American amateurs started writing to the heads of tourism of the governments jamming our 40m phone band we might have a chance of some favorable action. We could then get friends and neighbors to send letters, write about it in the papers, talk about it over the broadcast stations, etc. This could carry a lot of weight. Copies of the news clippings and copies of the letters should be sent to the officials of the airlines serving the countries...or their national airlines, if they come here.

This may sound like a lot, but one single person could organize it, if he decided to take the matter into his own hands.

I am sure that we could come up with a lot more good ideas which would put pressure on the SWBC stations.

Please let me know what you hear from Huntoon. I would love to be pleasantly surprised by a favorable reply from him to your suggestion. I do not expect to be surprised.

... Wayne

SCOOP!

Watch for Linear Systems' all-new SB-35 transceiver, to be unveiled at the Harrison Show this month. Diane Shaw, 73 Advertising Manager, got a "sneak preview" of the transceiver recently when David Bradley gave her a tour of Linear Systems' Watsonville, Calif. facilities.

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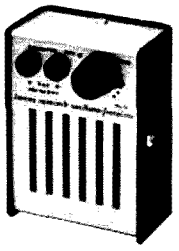
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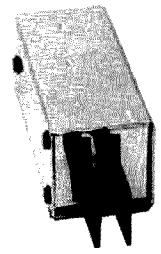
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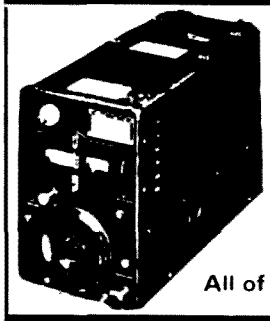
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_____ **Call**

Address _____

_____ **Zip** _____

PROPAGATION CHART

J. H. Nelson

Good O Fair (open) Poor ☐

April 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
			(1)	2	(3)	(4)
(5)	(6)	[7]	8	(9)	(10)	(11)
12	13	14	(15)	(16)	17	(18)
(19)	(20)	(21)	(22)	23	[24]	25
26	(27)	(28)	(29)	(30)		

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	14	7A	7	7	7	7	14	14	21	21
ARGENTINA	21	14	14	14	7	7	14A	21A	21A	21A	21A	21
AUSTRALIA	21A	21	14	14	7A	7B	7B	14B	21	14	21	21A
CANAL ZONE	21	14	14	14	7	7	14	21	21A	21A	21A	21
ENGLAND	14	7	7	7	7	14	21	21	21	21A	21	14
HAWAII	21A	21	14	14	7	7	7	7B	14	21	21	21A
INDIA	14B	14B	7B	7B	7B	7B	14	21	21	14	14	14
JAPAN	21	14	14	7B	7B	7B	7	7	7B	14	14	21
MEXICO	21	14	14	7B	7	7	14	21	21	21A	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7B	14B	14	14	14	14
PUERTO RICO	14	14	7A	7	7	7	14	21	21	21A	21A	21
SOUTH AFRICA	14	14	7	14	14B	14	21A	21A	21A	21A	21	21
U. S. S. R.	7	7	7	7	7B	7B	14	21	21	14	14	7B
WEST COAST	21A	21	14	7A	7	7	7	14A	21	21	21	21A

CENTRAL UNITED STATES TO:

ALASKA	21	21	14	7A	7	7	7	7	14	21	21	21
ARGENTINA	21	21	14	14	14	7	14	21A	21A	21A	21A	21A
AUSTRALIA	21A	21	14	14	14	14	7B	14B	21	14	21	21A
CANAL ZONE	21	21	14	14	14	7	14	21	21A	21A	21A	21A
ENGLAND	14	7	7	7	7	7B	14	14	21	21A	21	14
HAWAII	21A	21	14	14	14	14	7	7	14	21	21A	21A
INDIA	14B	14	14	7B	7B	7B	7B	14B	14	14	14	14
JAPAN	21	21	14	14	7B	7B	7	7	7B	14	14	21
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	21	14	14	7B	7B	7B	7B	14	14	14	14
PUERTO RICO	21	14	14	14	7	7	14	21	21	21A	21A	21
SOUTH AFRICA	14A	14	7A	7A	7B	7B	14	21	21A	21	21	21
U. S. S. R.	7B	7	7	7	7B	7B	7B	14	21	14	14	7B

WESTERN UNITED STATES TO:

ALASKA	21	21	14	7A	7	7	7	7	14	14	21	21
ARGENTINA	21	21	14	14	14	14	7B	14A	21A	21A	21A	21A
AUSTRALIA	28	28	21A	21	14	14	14	7B	14	14	21	21A
CANAL ZONE	21A	21	14	14	14	7	7	14A	21A	21A	21A	21A
ENGLAND	14	7B	7	7	7	7	7B	7B	14	21	14	14
HAWAII	28	28	21	21	14	14	14	7	14	21	21A	21A
INDIA	14	21	14	7B	7B	7B	7B	7B	14	14	14	14
JAPAN	21A	21	21	14	7B	7	7	7	14	14	14	21
MEXICO	21	21	14	7	7	7	7	14	21	21A	21A	21
PHILIPPINES	21A	21A	21	14	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	14	14	14	7	7	14	21	21	21A	21A
SOUTH AFRICA	14	14	7	7B	7B	7B	7B	14	21	21A	21	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	7B	14	14	14	7B
EAST COAST	21A	21	14	7A	7	7	7	14A	21	21	21	21A

A - next higher frequency may be useful
B - difficult circuit this period

WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO 73

No. 116

ACE
$1.00

EMPHASIS:
MOBILE OPERATION



ACTUAL SIZE

Features:

FCC:
REPEATER DOCKET
(WITH COMMENTS)
page 20

4-LETTER WORDS
page 2

BUILD THIS 3/4 INCH MICROMINIATURE SIX METER TRANSMITTER

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Amateur Radio News Page

May XIXLXX | Monthly Ham News of the World | 73 Magazine

FCC SAYS NO WORDS ARE NO-NO'S

The FCC questioned CB'er Richard Tallman's qualifications to hold a Technician-class amateur license because of his prior violations of rules pertaining to: (1) hobby-type use of his CB station, (2) failure to identify his station properly, and (3) transmission of "allegedly obscene, indecent, or profane language, words, or meaning." In scheduling a hearing for the case, the constitutional issues raised by the FCC's rule against profanity were noted by Commissioner Nicholas Johnson.

Johnson concurred that a hearing should be held to determine the applicant's qualifications to become a ham, but he emphasized that the "profanity" issue should be dismissed. "I believe a license renewal hearing on the basis of the first two alleged violations is clearly warranted," he said; but then he added, ". . .when we revoke licenses for the *content* of the speech. . .we enter an area of constitutional law which is hedged with important restraints against the power of government to curtail freedom of speech." Because of a recent supreme court decision involving the impact of the First Amendment on broadcasting, Johnson said, the Federal Communications Commission cannot punish—"by fine, license revocation, one-year re-



"Agh! By golly — by golly!"

'vagueness' and 'overbreadth.' See, *e.g., Zwickler v. Koota*, 389 U.S. 241, 249 (1967); *Columbia Broadcasting System (WBBM-TV)*, 18 F.C.C. 2d 124, 143, 150 (1969) (dissenting opinion). It might easily constitute a prohibited 'establishment of religion' as well."

"Webster's Dictionary defines the word, 'indecent,' as 'not proper and fitting; unseemly; improper,' or 'morally offensive; immodest; obscene.' Again, unless 'indecent' is narrowly limited to the technical definition of

Ham Wins Test Case

A Chesapeake, Virginia ordinance against transmitters and towers was defeated in the courts recently by Gay Milius W4NJF, who was acting as attorney for Ted Anthony K4OQB, in a civil case that tested the legality of the regulations.

Tri-State Hamfest

by WA9WCE

The Tri-State Amateur Radio Society is holding its twenty-third annual hamfest on Sunday, July 12, 1970, at the 4-H Rural Youth Center on Highway 41 North, Evansville, IN. Advance registration $1.50; and $2.00 at the door. For details contact Jack Young K9LAU, Box 492, Evansville, IN 47703.

British Carnival Rally

by G3BID

By permission of the United States Third Air Force, the Amateur Radio Mobile Society will be holding a carnival rally on 5 July 1970 at Alconbury, United States Air Force Base in

Cook Bicentenary Award

The Wireless Institute of Australia has a nice certificate available for anyone contacting fifty AX stations during 1970. Send a list of the stations you have contacted in order of call signs by call areas plus the date, time (GMT), band, mode, and report for each contact. Have this list certified by two other licensed amateurs plus a statement to the effect that they have seen the entries in your log. Send your application (no QSL's) to Awards Manager WIA, Box 67, East Melbourne, Vic., 3002, Australia. Add eight IRC's if you would like the certificate by airmail.

Western Illinois Hamfest

The Western Illinois Amateur Radio Club is holding its 10th Annual Hamfest on June 7th, 1970, at the Adams County Fairgrounds located North and

newal or other sanction"–a licensee "for speech which is protected by the First Amendment."

In his in-depth statement (published by the FCC as an appendix to Docket 18804), Commissioner Johnson gave detailed reasoning behind his controversial stand:

"The Commission has promulgated guidelines for forbidden speech in Rule 95.83 (a) (3). The Rule's prohibitions of "obscene, indecent or profane language, words or meaning" are apparently taken from 18 U.S.C. § 1464. Each of the three elements in Rule 95.83 (a) (3) warrants consideration, for I am increasingly of the belief that one or more of them are unconstitutional abridgements of the freedom of speech.

"The concept of 'obscenity' has been defined by the Supreme Court in the famous case, *Memoirs v. Massachusetts*, 383 U.S. 413,419 (1965). The Court has not, however, to my knowledge, ever said that particular *words* are 'obsene' *per se*. On the contrary, the Court has always stressed the *context* in which the words appeared, asking whether the dominant theme of the material 'taken as a whole' appeals 'to a prurient interest in sex.' Individual 'four-letter words,' so-called, may arouse a number of emotions in the listener; but I rather doubt that a 'prurient interest in sex' is one of them. Presumably the hearing examiner in this case will address this question – along with such other constitutionally required questions as whether Mr. Tallman's speech was 'utterly without redeeming social value.' A study of the function of 'four-letter words' in our society, for example, might be useful, or necessary, component of this latter inquiry. 'profane' as 'showing disregard or contempt for sacred things; irreverent.' Any attempt by this Commission to punish for 'contemptuous' or 'irreverent' speech would almost certainly, in my mind, suffer from unconstitutional 'obscenity,' there is little doubt in my mind that its breadth and vagueness make it unconstitutional. In *Interstate Circuit, Inc. v. Dallas*, 390 U.S. 676 (1968), for example, the supreme court cited with approval an earlier case, *Holmby Productions, Inc. v. Vaughn*, 350 U.S. 870 (1954), which declared unconstitutional a statute containing the words, 'cruel, obscene, indecent, or immoral.' And just last year in *Williams v. District of Columbia*, No. 20, 927 (D. C. Cir., June 20, 1969) (en banc), the United States Court of Appeals threw out a statute with wording almost identical to Commission Rule 95.83 (a) (3). The invalidated District of Columbia statute also contained the words, '. . .profane language, or indecent or obscene words.'

"My essential point is that this Commission has designated a license renewal application for hearing pursuant, in part, to Commission rules which appear unconstitutional on their face. I am concerned that the Commission takes this step without attempting to formulate precise standards for permissible speech over the broadcast medium – assuming *any* such standards could withstand constitutional scrutiny. I concur in today's action, however, solely because grounds exist for possible license revocation which are completely independent of the allegations raised under Rule 95.83 (a) (3), and because the Commission will have the opportunity at a later date to review the policy and law in this difficult area."

Slow-Scan Hams Active Worldwide

by WA7LQO

A world-wide slow-scan TV net has been meeting between 1800 and 2000 GMT weekdays. Stations in Alaska, Belgium, Sweden, U.S.S.R., Italy, as well as the U.S. and Canada have been sending pictures.

Huntingdonshire, England.

Any inquiries regarding the rally or regarding reciprocal licensing arrangements should be addressed to:

BCM/ARMS, London, W.C.I.

Application forms for British reciprocal licenses can be obtained from:

Ministry of Posts and
Telecommunications,
Telecommunications and Radio
Regulatory Division
Amateur & Special Licensing Branch
Waterloo Bridge House
Waterloo Road, London, S.E. 1.

The cost is £3 for a fixed license or £1.10 Od. for a Mobile License. Amateurs can apply for both, or either, but a separate mobile license is necessary in Britain for mobile operation.

1970 Ham-of-the-Year Award

The Federation of Eastern Massachusetts Amateur Radio Associations is now requesting nominations for the "Ham of the Year" award for 1970. Only amateurs in the first call district are eligible and the ham selected will be the top "good neighbor" among hams – the one who has performed an outstanding public service.

Anyone may nominate a ham for the honor. Winner of the award will be chosen for the ham activity which brings the greatest benefit to an individual or group and for the amount of ingenuity and personal sacrifice displayed in performing the service.

Nominating letters should include the candidate's name, address, call letters and complete description of the service performed. Letters must be sent to the chairman of the FEMARA awards committee, Eli Nannis W1HKG, 37 Lowell St. Malden, Mass. 02148 before September 1, 1970.

The winner will be presented with a plaque and a cash award at the ARRL National Convention, Statler-Hilton Hotel, Boston, Mass. on September 26, 1970.

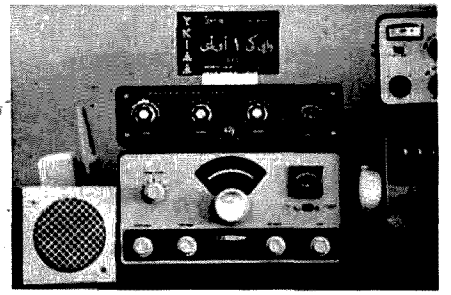
East of Quincy, Illinois.

Calling frequencies will be 3.910 MHz, 7.258 MHz (Mid-Cars) 146.94 MHz and 146.34 MHz 2 meter FM Repeater.

Swap-shop, prizes, games, lunch, ALL-COVERED FACILITIES. Event will be held rain or shine. Camping facilities are available on the fairgrounds.

For further info contact WA9ARG, Marshall Goins, 2316 Van Buren St., Quincy, Ill. 62301.

SYRIAN MARATHON OPERATION PLANNED



Rasheed YK1AA and Hikman YK1AM are planning a round-the-clock three week operation for October 1970, with extensive friday operations from then on through February 1971. The details of equipment are being worked out with Stu Meyer W2GHK/4 (DXpedition of the Month) and they should be on all bands with good signals. This ambitious operation should take Syria off the rare list for a long time to come. All it takes is one good effort like this to do it.

A copy of the 73 DX Handbook has been sent to Rasheed so he will have information on how to best handle the pileups of stations calling. Using the techniques described in this book he and Hikmat should be able to contact three to five a minute, even when their signals may not be too strong.

FCC Proposal Will Shoot Down Ham Satellites

The proposed Docket 18803 for regulating amateur repeaters has a serious hooker in it. . .a proposal that repeaters not be permitted to repeat other repeaters. If this gets passed, then a set of synchronous satellites for 450 MHz is out the window. This could be the most severely restrictive legislation yet for the future of amateur radio.

The rapid development of FM repeaters plus the amateur satellites means that the time is not far off when we can put a series of three synchronous satellites in orbit which will permit any amateur in the world to contact any other on 450 MHz. Imagine what a change that will make in our hobby! Armchair copy signals without QRM from anywhere in the world. This could be the biggest step ahead for the hobby since its inception. . .if 18803 does not go through as proposed.

Rear back and fight this one out. Send in your comments. . .get your club to comment. . .your friends. . .the fellows on the air. . .leave no stone unturned. Get your congressman to complain about this. . .your senator. . . get Barry Goldwater to help kill this provision. . .maybe even the ARRL.

Penn-Central Hamfest

by W3GPR

The seventh annual Penn-Central Hamfest by the Williamsport and Milton clubs will be held Sunday, June 7, 1970 starting at 12:00 noon at the Union Township Volunteer Fire Grounds on Route 15, Winfield, Penna. Informal, picnic style, snack bar handy or bring your own lunch – come and go as you please. Auction, contests, swapping, free parking, with both indoor and outdoor facilities provided. A $2.00 registration fee may be paid at the gate. XYL and children admitted free. Exhibits welcome. For information contact Al Schramm, 311 E. Mountain Avenue, South Williamsport, Penna. Phone - 717-323-5576.

1970 ARMED FORCES DAY COMMUNICATION TESTS

Each year on the third Saturday in May, the Department of Defense sponsors the observance of Armed Forces Day. As a part of this observance the Departments of the Army, Navy and Air Force annually conduct communication tests designed to demonstrate to the world the close partnership and mutual respect enjoyed between U. S. amateur radio operators and the U. S. military. This year's program will be conducted on Saturday, May 16, 1970, and all licensed radio amateurs are encouraged to participate.

The radio amateur's contributions to communication training, international goodwill, military morale and emergency services are recognized by every echelon of the military services. The Armed Forces Day communication tests are designed to be a tangible demonstration of the firm and long-standing Department of Defense policy to encourage and support amateur radio activity. On this twenty-first observance of Armed Forces Day, all radio amateurs are invited to participate and demonstrate to the world the close partnership and mutual respect that U. S. amateurs and U. S. military enjoy.

Once again this year, several military radio stations will participate in communication tests which include military-to-amateur crossband operations and receiving contests for both CW and RTTY modes of operation.

Special QSL cards confirming crossband communications will be forwarded to those amateurs who establish two-way contact with participating military stations. Certificates will be awarded to those who aptly demonstrate their operating ability and technical skill by receiving a perfect copy of the Secretary-of-Defense-originated CW or RTTY message transmitted during the receiving contest portion of the communication tests.

Military to Amateur Crossband Test

Military radio stations WAR, NSS, NPG and AIR will be on the air from 16/1400 GMT to 17/0245 GMT. During this test of crossband operations, the military stations will transmit on specified military frequencies while amateur stations will transmit in the indicated portions of the amateur bands. Contacts will consist of a brief exchange of locations and signal reports. No traffic handling will be permitted.

CW Receiving Contest

A "CW" receiving contest will be conducted for any person capable of copying International Morse Code at 25 words per minute. The "CW" broadcast will consist of a special Armed Forces Day message from the Secretary of Defense addressed to all radio amateurs and other participants. The schedule for this broadcast is as follows:

STATION	MILITARY FREQUENCY	EMISSION	APPROPRIATE AMATEUR BAND (MHz)

TIME	TRANS. STATION	FREQ (kHz)

News, Reviews, Announcements

IOWA PICNIC

by WØRJZ

The Iowa 75 meter phone net annual picnic will be held on the second Sunday in August – August 9, 1970 – at Anson Park in Marshalltown, Iowa. All amateurs and their families are cordially invited. Each should bring a covered dish and his own service. Festivities will begin around noon. Prizes will be offered and a swap table will be available.

Floridafest

The ST. PETERSBURG AMATEUR RADIO CLUB, INC. will hold its annual Hamfest at Lake Maggiore Park, entrance gate at 9th Street South and 38th Avenue, St. Petersburg, Florida, Sunday May 17. All hams and guests cordially invited. This is an oldfashioned hamfest with picnic lunch, swap table and prizes.

OLD OLDTIMERS GET NEW OFFICERS

Andrew L. Shafer W8TE is the new president of the Old Old Timers' Club, Inc. with William B. Gould K2NP as the new Vice President.

Ray Meyers W6MLZ has been appointed Executive Secretary-Treasurer and Editor of "Spark Gap Times" official magazine for the OOTC.

Directors serving the ten U.S. Call Areas are:

	District
Walter S. Rogers W1DFS	1
William B Gould K2NP	2

	kHz unless otherwise noted		
WAR (Army Radio, Wash., D.C.)	4001.5	CW	3.5 - 3.65
	4020	CW	3.65 - 3.8
	6992.5	CW	7.0 - 7.1
	7325	CW	7.1 - 7.2
	14405	CW	14.0 - 14.2
NSS (Naval Communication Station, Wash., D.C.)	*3385	CW	3.5 - 3.65
	4012.5	RATT	3.65 - 3.8
	*4040	LSB	3.8 - 4.0
	6970	LSB	7.2 - 7.25
	**7301	CW	7.1 - 7.2
	**7336	LSB	7.25 - 7.3
	7380	RATT	7.0 - 7.2
	7385	CW	7.0 - 7.1
	13940	RATT	14.0 - 14.1
	14385	USB	14.2 - 14.35
	14400	CW	14.0 - 14.2
	21500	CW	21.0 - 21.25
	***49.692 MHz	AM	50.1 - 54.0
	***143.820 MHz	AM	144.0 - 145.5
	***150.090 MHz	FM	144.0 - 147.9

*To be operated from 16/2200 GMT to 17/0245 GMT.

**To be operated from 16/1400 GMT to 16/2200 GMT.

***Provided it is consistent with operational and training commitments, this frequency will be keyed from a U.S. Navy aircraft flying between Washington, D. C., and Brunswick, Maine, between 16/1200 GMT and 16/1430 GMT. The aircraft will depart Brunswick, Maine at 16/1730 GMT and fly westerly to Akron, Ohio, Southerly to Morgantown, West Virginia, and return to Washington, D. C. at approximately 16/2100 GMT. The call sign NSSAM will be utilized from the aircraft.

NPG (Naval Communication Station, San Francisco, Calif.)	4001.5	LSB	3.8 - 4.0
	4005	CW	3.5 - 3.65
	4016.5	RATT	3.65 - 3.8
	7301.5	LSB	7.2 - 7.3
	7347.5	RATT	7.0 - 7.2
	7365	CW	7.0 - 7.1
	7495	CW	7.1 - 7.2
	13922.5	RATT	14.0 - 14.1
	13975.5	CW	14.0 - 14.1
	14356	USB	14.2 - 14.35
	14375	CW	14.1 - 14.2
	20954.5	CW	21.0 - 21.25
	21600	USB	21.25 - 21.45
	#143.700	AM	144 - 148
	##148.410	FM	144 - 148
AIR (Air Force Radio, Wash., D.C.)	3347	CW	3.5 - 3.8
	4025	LSB	3.8 - 4.0
	6997.5	CW	7.0 - 7.2
	7305	LSB	7.2 - 7.3
	7315	RATT	7.0 - 7.2
	13995	CW	14.0 - 14.2
	14397	USB	14.2 - 14.35
	20994	CW	21.0 - 21.1

#Provided it is consistent with operational and training commitments, this frequency will be keyed from a U.S. Navy aircraft flying between San Diego, California, and Seattle, Washington during the major portion of the time allotted for military to amateur crossband contacts. The call sign NPGAM will be utilized on the aircraft.

##To be operated from Mt. Diablo

TIME	TRANS. STATION	FREQ. (kHz)
16 May 1970		
17/0300 GMT	WAR - Army	3347, 6992.5, 14405
16/2300 EDST	NSS - Navy	3385, 7385, 14400, 21500
16/2000 PDST	NPG - Navy	4005, 7495, 13975.5, 20954.5
	AIR - Air Force	3397.5, 7315, 13995
	A6USA - Army Radio San Francisco	6997.5

RTTY Receiving Contest

A radioteletypewriter receiving contest will be conducted for any individual amateur or station possessing the required equipment. This is a test of the operator's technical skill in aligning and adjusting his equipment, and serves to demonstrate the growing number of amateurs becoming skilled in this method of rapid communications. The "RTTY" broadcast will consist of a special Armed Forces Day message from the Secretary of Defense to all radioteletypewriter enthusiasts. The message will be transmitted at 60 words per minute in accordance with the following schedule:

TIME	TRANS. STATION	FREQ. (kHz)
16 May 1970		
17/0335 GMT	WAR - Army	3347, 6992.5, 14405
16/2335 EDST	NSS - Navy	4012.5, 7380, 13940
16/2035 PDST	NPG - Navy	4016.5, 7347.5, 13922.5
	A6USA - Army Radio San Francisco	6997.5
	A5USA - Army Radio Fort Houston TX	4025

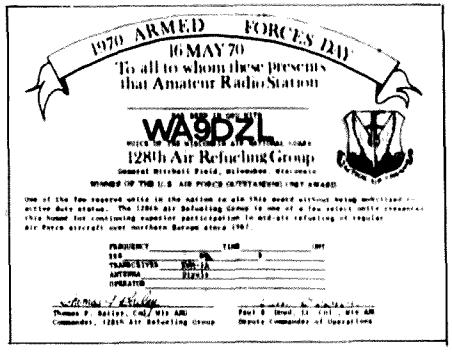
Submission of Competition Entries

Transcriptions should be submitted "as received." No attempt should be made to correct possible transmission errors.

Time, frequency and call sign or the station copied as well as the name, call sign (if any) and address of the individual submitting the entry must be indicated on the page containing the text. Each year a large number of perfect copies are received with insufficient information, thereby precluding the issuance of a certificate.

Completed entries should be submitted to the Armed Forces Day Contest, ATTN: AFOCCOM, Room 3E099, James Forrestal Building, 1000 Independence Ave., Washington, D. C., 20330, and postmarked no later than 31 May 1970.

Thomas Appleby 3
Raymond F. Guy W4AZ 4
Walter M. Hammond W5BN 5
Robert Holly W6DRV 6
Lawrence S. Linville W7DH 7
Andrew L. Shafer W8TE 8
G. Lane Eldred W9SG 9
Ed. Freeman WØMOA 10



Military Hams to Award Armed Forces Day Certificates

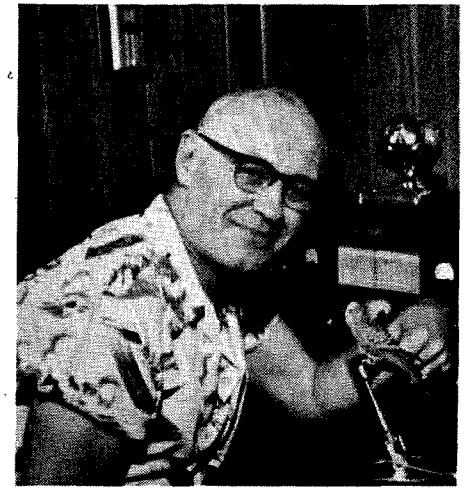
by WA9NVO

On Saturday, May 16, 1970, WA9DZL, amateur station of the 128th Air Refueling Group (TAC), Wisconsin Air National Guard will place radio equipment on the ham bands in conjunction with Armed Forces Day. An attractive commemorative Armed Forces Day certificate will be mailed to all hams who contact WA9DZL on this day. The operating schedule is as follows:

14.297 MHz	1300 GMT – 2100 GMT
7.280 MHz	1300 GMT – 1730 GMT
28.650 MHz	1730 GMT – 2100 GMT

It is anticipated that all states and continents will be contacted. To qualify for a certificate, just make a two-way contact with WA9DZL and send in your QSL card to WA9DZL, 128th Air Refueling Group (TAC), General Mitchell ANG Base, Milwaukee, Wisconsin 53207.

Editorials



DXer's Death is Loss To All Ham Radio

by W. R. Lathrop W4PR

The amateur radio fraternity lost one of its great citizens on March 7, 1970 when E. C. Atkerson died unexpectedly of a heart attack. Ack – hardy, robust, energetic – had his first warning last fall when he was hospitalized from a serious heart attack. He recovered quickly, continued under doctors' orders, dieted, took care of himself, and alowed his active business pace. However, there came a second attack on Saturday and Ack died instantaneously.

Ack loved amateur radio. He began in 1921. He dovoted himself, over the years, not only to enjoying this fascinating hobby but in using his facilities in service to his country as well as the general public. His profound self-taught knowledge of electronics, for example, was voluntarily put to use in the last world war. The country then with a client. Yet, let a child walk in, whose head perhaps didn't reach far above the counter, one who professed an interest in becoming a radio amateur and Ack would "give him the store." Despite the rush of business, he would take time out – sometimes for hours to explain, advise, and lead the youngster toward his goal. More often than not the youngster would walk out with needed equipment even though he did not have the money to pay for the items wanted. He never lost interest in these children, and he continued to help and advise throughout their amateur careers. Ack was particularly generous in donating equipment new and used. He was instrumental in providing most of Alabama's civil defense equipment in the early days. Since Ack never talked about what he did and to whom he sent equipment, there is no telling how much gear he packaged and sent at cost or free of charge to needy hams, missions, and the like.

Ack particularly loved animals of all kinds. Out of hundreds of such stories illustrating his kindness to the animal kingdom, one should suffice which fully illustrates this trait. One day he found a pigeon with a broken wing outside his store. He personally took it to the veterinarian, had it treated, nursed and treated it back to health. He footed the bill and freed the bird on its recovery. He never spoke of what he had done.

Virtually the whole DX fraternity knows and appreciates Ack's interest and help in his efforts in this direction. Few know, however, of the tremendous difficulties, the sweat, the hard work, and the time involved in doing the necessary to receiving permission for Gus, W4BPD, to operate from the various exotic places that he visited. Nor do few know the personal expense, the vexation, the many problems met and solved or of the thousand and one other details carried on by Ack in connection with Gus' travels. It was Ack's idea, thinking of the small Propagation Study Association were available when Don's partner, Chuck Swain, was lost at sea. He did much to keep the search going until hope was finally abandoned.

Then came again a second Gus Browning expedition with all the work and effort which Ack shouldered without hesitation. These three well known expeditions tell part of the whole story. Ack's personal interest, his energy and drive were, however, lent to countless expeditions. Financial help, on Ack's suggestion, sometimes came from the World Radio Propagation Study Association. Ack personally contributed his own money and equipment and help in countless sorts.

Although there is much more, let one more example of Ack's influence and interest suffice. Through a long-time radio communications correspondent and friend, N. Chhwana, a high official of the Bhutan government, Ack arranged to have the king invite Gus to visit that country. As a result of that visit a strong friendship was developed and knowing, through Gus, of the Bhutan's needs of radio equipment, Ack shipped much equipment to the government of Bhutan, much of it at his own expense. Then through personal appeals to many radio friends and appeals through the World Radio Propagation Study Association, Ack collected and shipped a tremendous amount of radio equipment to Bhutan – all donated.

Yes, amateur radio lost a devoted, amazingly helpful citizen when W4-Echo-Charlie-Ida's cheerful voice was silenced! We all owe him much. Truly Ack deserves a top spot in amateur radio's Hall of Fame.

Bermuda Phone/CW

change reports with U.S., Canadian and VP9 stations only. U.S. and Canadian stations may not exchange reports with another U.S. or Canadian station; likewise U.K. stations may not exchange reports with other U.K. stations.

Points

Each contact must be complete and will count three points.

Scoring

The score for U.S., Canadian and U.K. stations will be the number of completed contacts times three points, times the total number of Bermuda Parishes worked on all five bands, i.e. a U.S. or Canadian station having made a total of 500 contacts with U.K. and Bermuda stations and the following Bermuda Parishes: 28 MHz - three Parishes; 21 MHz - six Parishes; 14 MHz - three Parishes; 7 MHz - two Parishes; 3.5 MHz - two Parishes, the score would be 500 contacts times three points = 1,500 points times 16 Parishes = 24,000 points final score. A U.K. station completing 500 contacts with U.S., Canadian and V P 9 stations would score in exactly the same manner.

Equipment

Any number of transmitters and receivers will be allowed and competitors may use the maximum power permitted. However, all stations participating must be single operator only.

Awards

A trophy will be presented to the winner of each mode. A certificate signed by His Excellency The Governor of Bermuda will be sent to the highest scoring station in each call area as follows:

U. S. A. and Canada: W1 through WØ and VE1 through BE7 including VO.

U. K.: G, GD, GM, etc.

Presentations

Round trip air transportation for two plus one week's accommodation at

had need of a tremendous number of technicians to operate the radio gear used during that war. Ack volunteered to teach and to train technicians. He did so during the war period. All along before and after the war he used his facilities wherever possible for traffic handling. On the second Byrd expedition to the Arctic in 1939, Ack established and maintained constant contact with the expedition. Interestingly enough, the expedition was split into two camps some 1800 miles apart. There was an eastern location and a western location and they took radio equipment along to maintain contact between the two camps. Little was known about propagation in the Arctic in those days and much to Byrd's dismay the contact between the two camps was impossible with the equipment on hand. Ack could copy, however, both camps. He therefore linked the two together by maintaining twice-daily contact. He handled all the communications between the two units until suitable radio equipment was sent in. During the period of the Byrd expedition he handled thousands of personal messages from those with Admiral Byrd to their families throughout the United States.

Again in prewar days he established contact with the Kenner–Green scientific expedition to Peru. He was their main contact with the outside world for that expedition deep in the jungles of this South American country. Ack later rendered tremendous service to families throughout the United States when a volcano in Hawaii blew its top causing untold damage and destruction. Ack's station was the principal radio link.

Ack's interest in amateur radio caused him to found Ack Radio shortly after the last world war. Ack was an alert, capable, hard working, imaginative, "tough" businessman, and Ack Radio grew and thrived. He might well have been abrupt and business-like amateur without funds, who insisted on QSLs for everyone regardless of their contribution.

The World Radio Propagation Study Association also was Ack's idea. Not only did this organization act as a recipient of, and a disposal medium for the contributions from thousands of amateurs, but the analysis of Gus' logs and the propagation conditions pertaining to it were studied to provide benefits for amateurs the world over, the governments visited and various commercial interests. These studies were made and distributed.

After Gus' first extended travels, the World Radio Propagation Study Association backed and sent Don Miller on a similar expedition. Ack saw to it that funds from the World Radio



160m DX

by W8ANO

During November 1969, Stewart W1BB came out to the 8th district to see what was making all the racket on 160 meters. Here is what he found: Three 8s very interested in 160 meter DX. I have worked the following 160m DX since Nov: ZS, HR3, PJØ, KP4, VP9, KV4, HR2, ZL1, G3, GW3, DL9, KL7, G2, G8, KS4, VK5, VO1, VK3, KH6.

Contest

by Jim Sayer VP9BY

Bermuda hams have been active participants in the realm of amateur radio since well before the inception of the Radio Society of Bermuda in the late forties. Several of the old single-letter calls are still to be heard. In 1959, in honor of the Bermudas' 350th Anniversary it was decided to hold a contest embracing amateurs in the United States, Canada, and Bermuda. This proved to be such a resounding success that it was continued in 1960 and has been a yearly feature of hamdom since that time.

In 1969, the 10th anniversary of the contest, it was decided to celebrate by having a phone weekend and a CW weekend. This decision was met with equally resounding success and it was agreed to continue the same this year and to invite the U. K. amateurs to participate.

Contest Period

PHONE: 0001 G.M.T. June 20th to 0200 G.M.T. June 21st.

C. W.: 0001 G.M.T. July 18th to 0200 G.M.T. July 19th.

Bands

The following amateur bands will be used: 3.5, 7, 14, 21, and 28 MHz.

Exchanges

Amateurs in the U.S., Canada and the U.K. will transmit a two figure number representing the R S report plus their State, Province or County. CW participants will transmit a three figure number representing the R S T report plus their State, Province or County. V P 9 stations will give R S or R S T reports plus Parish.

U.S. and Canadian stations may exchange reports with U.K. and VP9 stations only. U.K. stations may exchange reports with U.K. and VP9 stations only. The Top of the Town Hotel will be provided to enable the overall winners to attend The Radio Society of Bermuda's Annual Banquet to be held on October 22nd to receive their awards.

Log Instructions

Keep all times in GMT and all contestants to compute their own scores and check logs for duplication to assist the Contest Committee. Print name and Call on each Log. All contestants must sign a statement that the rules and regulations have been observed. Official Log sheets can be had by dropping a card to Contest Committee, Radio Society of Bermuda, P.O. Box 275, Hamilton, Bermuda.

Should there be a tied score, the decision of the Contest Committee will be final. All Logs must be received by the Contest Committee of the Radio Society of Bermuda NOT LATER THAN August 15th, 1970.

The following abbreviations of Parishes will be used on CW.

SANDYS	SAN.
DEVONSHIRE	DEV.
PEMBROKE	PEM.
WARWICK	WAR.
SOUTHAMPTON	SOU.
SMITHS	SMI.
HAMILTON	HAM.
PAGET	PAG.
ST. GEORGE	GEO.

RaRa HAMFEST

The Rochester Amateur Radio Association invites you to the 1970 Western New York Hamfest and VHF Conference. Organizing the Hamfest is an all-year effort by a good many of the members of RaRa, a Rochester ham club. Special tables can be reserved for clubs and groups. Check at the registration desk to see where your group can be seated.

An impressive program is planned for the occasion, and special activities are being scheduled for FM enthusiasts.

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. Include your check with order.

Deadline for ads is the 1st of the month two months prior to publication. For example: January .1st is the deadline for the March issue which will be mailed on the 10th of February.

Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

For $1 extra we can maintain a reply box for you.

We cannot check into each advertiser, so Caveat Emptor. . .

FOR SALE: NCX-5, NCX-A, VX-501, NCL-2000, 20A, Bandhopper VFO, G-76, 12V Supply, Ham-M Rotor, #14 Typing Reperf, Regency AR-136 Aircraft Receiver, RCA Mark 8-10 Meter Transceiver, Ameco Nuvistor converters CN-50, CN-144, PS, 14MC IF. Sorry no shipping. Write K3DSM Gene Mitchell 335 Conestoga Rd. Devon PA 19333.

2 METER MOS FET PRE-AMPS Latest-protected Dual Gate MOS FET. HF-144 DGK-Kit $9.50-Wired $14.50. Minimum 18 dB gain. Noise figure less than 3 dB. Topeka FM Engineering, 3501 Croco Rd. Topeka KS 66605.

FM RECEIVER Portable, Heathkit, Tunable, Model GR-88. Tunes from 145 to 167 MHz. Battery operated. Exc. sensitivity and selectivity for monitoring local repeater outputs. Like new. $50. Ken Sessions K6MVH, RFD 2, Peterborough NH 03458.

TOUCHTONE DIAL equivalent from Denmark. Ten button, convertible to all twelve with data included. State color: beige or black, limited number green. 12VDC required for oscillator operation. $16.00 postpaid USA. J. O'Brien, WB6WIM, 6606-5th Street, Rio Linda CA 95673.

TOWER HEADQUARTERS! 12 Brands! Heights Aluminum 35% off! Antennas—20% off! Galaxy, Hammarlund, Gonset, SBE at discount. Catalog—20¢. Brownville Sales Co. Stanley WI 54768.

40th ARRL WEST GULF DIVISION CONVENTION July 17, 18, 19, Orange, Texas. Come by car, plane, or boat, but come to the fun, fellowship and entertainment. A bargain you can't afford to miss. Registration $8.50. Orange Amateur Radio Club, Box 232, Orange TX 77630.

HICKOK 610A TV Sweep-Marker Generator Exc $75. 73 Magazines #1 thru Nov. '67 Perfect. Write Maurice Lindenaux 2042 Druid Rd, Clearwater FL 33516.

FM: T43G—1, head, mike, speaker, 146.94 xtals, 12 volt, wide band, unconverted as yet; make offer! TR-108: $85. WA9BYR, 627 Dundee Ave., Barrington IL 60010.

CHICAGO NOVICES: complete station. Allied 2515, DX-40, relay, trap dipole, key. $110.00. Will deliver, help install within 50 miles. K9FRZ, 7620 Catalpa, Chicago IL 60656.

SELL perfect Heath-aligned SB-301. Will ship, $210 FOB. Will consider FM gear partial trades. WB6QVW, Andrew Ellis, Box 202, Stevenson College, UCSC, CA 95060.

WORLD RADIO'S used gear has trial - guarantee! Clegg Interceptor - $199.95; 22'er - $129.95; KWM2A - $749.95; Swan 250C - $249.95; 350 - $289.95; 500C - $379.95; NCX3 - $159.95; HW22 - $79.95; DX60 - $49.95; HT40 - $49.95; HT44 - $149.95; SX101 - $159.95; HQ110A - $139.95; 2A - $159.95; HRO50 - $129.95. Free "blue-book" list for more. 3415 West Broadway, Council Bluffs IA 51501.

HOT CARRIER DIODES: HP2800 90¢ 12/$10.00. IC's: New Fairchild MicroLogic (epoxy TO-5) 900, 914,60¢, 923 90¢. Motorola MC790P $1.90, 20/$18.00 MC789P, MC724P $1.05, 10/$9.50. OP AMP: TI SN72709N $2.00, 6/$10.00. All guaranteed. Add postage. Write for list. HAL Devices, Box 365L, Urbana IL 61801.

INDIANA'S MOST PROGRESSIVE HAMFEST Sunday, May 24, rain or shine. Sponsored by Wabash Co. Amateur Radio Club. Write Bob Mitting, 700 Centennial, Wabash IN 46992.

SWAN CYGNET 260—including microphone and mobile mount. First $325 check gets all. William O'Byrne, 3569 Ft. Meade Rd., Laurel MD 20810. 301-498-1777.

DTL INTEGRATED CIRCUITS: Guaranteed New - gates 70¢, buffers 80¢, F/F 90¢, dual F/F $1.15. Add 20¢ postage. Also other inexpensive parts. Lists & prices from Mitch-Lan Electronics Co. Dept 270, P.O. Box 4822, Panorama City CA 91402.

END CARD PROBLEMS. Frame, protect, store or display 200 QSL's in 20 card plastic holders for $3.00, prepaid and guaranteed. TEPABCO, Box 198, Gallatin TN.

NOVICE CRYSTALS: 40-15M $1.33, 80M $1.83. Free Flyer. Nat Stinnette Electronics, Umatilla FL 32784.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd, PA 19004.

"TOWER HEADQUARTERS!" 11 Brands! Heights aluminum 35% off! Strato Crank-ups, low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co., Stanley WI 54768.

TWO REMINGTON SYNCHRO TAPE MACHINES for sale. Price for both $240, plus shipping. No instruction manuals. R. Lee K4BAP, 660 Poinsettia Ave, Titusville FL 32780.

SELL SX-111, like new-$100; VFO-$15; CIE correspondence course-$80; Stancor 5VCT-60A-$20. Drewing-WB2SMQ, 628 Anchor Ave., Beachwood NJ 08722.

WANTED 3-1000Z or 4CX1000A, fil. xfmr. and socket. Also need xfmr.-3000 VDC-1A. Drewing-WB2SMQ, 201-349-9253, 628 Anchor Ave., Beachwood NJ 08722.

WIRELESS SHOP—new and reconditioned equipment. Write, call or stop for free estimate. 1305 Tennessee St., Vallejo CA 94590 (707-643-2797).

TOP SECRET! Classified frequencies: spies, NASA, military, emergency networks, many more! $1.00. Electronic Development Incorporated, 1918 49th Street East, Palmetto FL 33561.

Tristate Hamfest

by K9VAT

The Western Illinois Radio Club composed of radio amateurs in the tristate area, is sponsoring a hamfest at the Adams County Fair Grounds, Mendon, Illinois on June 7, 1970. A fine program of an entertainment nature is planned for radio amateurs and their families. Seven-hundred people attended the last hamfest and family picnic.

It has been more or less traditional at these events to give away door prizes as attractions to improve attendance and participation. In the past years the various manufacturers and distributors have been very generous and gracious in donating an assortment of prizes frequently used by radio amateurs.

Certificates...

For the Ham Who Has Everything

RRCC — Real Rag Chewers Club.

This certificate is available to amateurs who furnish a signed statement that they have had a continuous radio contact lasting over six hours with one other amateur station. Continuous means just that. . .no time out for anything. On your application, list starting and ending time and date. Please include $1 to cover the costs of handling and mailing.

WAAS — Worked Almost All States.

This certificate is available to amateurs who furnish QSL cards proving two-way radio contact with 49 states. This will greatly ease the anguish of not being able to get that last state. Please include $1 to cover costs of handling and mailing.

FM MOBILE TRANSCEIVER 450 MHz, 2-Channel trunk mount RCA rig in perfect condition. Fully duplexed and operating as a mobile telephone. Includes transmit crystals for 442.12 and 442.05; receive crystals for 448.82 and 448.85. Crystals are from Sentry and are enclosed in ovens. Complete less control head and cables: $100. Will throw in two 4 dB Com Prod mobile gain antennas. Ken Sessions K6MVH/1, RFD 2, Peterborough NH 03458.

FM MOBILE/PORTABLE TRANSCEIVER 2 meters. Varitronics FDFM2. Perfect for repeaters. Six crystal-controlled channels included: .34—.94, .94—.94, .34—.76, .31—.88, .22—.94, .28—.76. Crystals are International. Includes 12V battery pack, mobile battery cable w/connector. $200. Ken Sessions K6MVH/1, RFD 2, Peterborough NH 03458.

FOR SALE: Heathkit DX100 (B) $55; Hallicrafter HT40 $45; National NC98 RCVR $50; Homebrew 2 Watt 2 Meter Transceiver $25. J. Middleton, 132 Forest Hill Road, W. Orange NJ 07052. WA2GVQ.

COMPLETE SET 73's for sale & singles from 1961. Make offer to Art Becker, 535 Clyde Apt. 29, Calumet City IL 60409.

ELECTRONIC ORGANS Transistorized, known brand, electronic assemblies, two manual spinet. $60.00 f.o.b., send SASE for particulars. W9YCB, Rural Route 2, Box 52A, Angola IN 46703.

MOTOROLA BRICK (H 23-DCN) with Nicad and case, on frequency .34—.94 and .94—.94, $300. ITT 30W 12DC mobile, complete with all accessories, less crystals, $100. Budelman 17-A frequency-deviation meter, crystal controlled with crystals for 146.94 and 52.525 with manual, $75. Philip Dater, WA5JDZ, 9006 Crestwood, Albuquerque NM 87112.

CAPACITORS, SPRAGUE 125 uF 450V 59¢, 40 uF 450V 29¢ 12V transistor. Inverter Transformers, 670V @ 250 ma $3.95. Minimum Order $5.00. N.M.E. P.O. Box 1306, Newport Beach CA 92663.

ALL MY HAM EQUIPMENT: HE 45B 6 meter Transceiver; Eldico 2 meter transmitter; Navy receiver with converter; complete with power supplies; 16 element Telerex antenna. $150.00 complete. WB2HPS Hicksville NY 11801.

TONE DECODERS:Touchtone-Digital -Burst. Solid-state, modular, plug-in unit, 2 x 2 x 3 in., $22.50 postpaid. ITT 12-button tone dial, $27.50. Write Digitone, Box 116, Portsmouth OH 45305.

SPECIAL OF THE MONTH RG 11A/U Coaxial Cable, 1st quality, Brand New—12¢ a foot or any length to 2500 feet. Antennas, Inc. Dept. B, 512 McDonald Road, Leavenworth KS 66048.

HOT CARRIER DIODES: New HP 2800, 90¢ 12/$10 pp. H A L Devices, Box 365L, Urbana, IL 61801.

INTEGRATED CIRCUITS: New Fairchild Micrologic, epoxy TO-5 package, 900 buffer, 914 gate, 60¢ each. 923 J-K flip-top, 90¢ each. Guaranteed. Add 15¢ postage. H A L Devices, Box 365L, Urbana, IL 61801.

OP AMPS: Texas Instruments SN72 709N (DIP) $2.00 each, 6/$10.00. Add postage. H A L Devices, Box 365L, Urbana IL 61801.

GREENE: center dipole insulator with . . .or. . .without balun. . .see November 73, Page 107.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class License. plus "Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

SRRC HAMFEST—June 7, Come to 4-H Fairgrounds Southwest of Ottawa, Illinois via Route 71. For data contact W9MKS, RFD 1, Oglesby IL.

MINT COND: Apache and SB-10 SSB Adaptor, plus cables and mike-Reasonable offers considered. J. Weatherly K1ZYG 473 Auburn, Newton MA.

SALE—teletypes Model 15-$60; Model 19—$90; AN/FGC-IX audio converter $25; Hornet TB-3B Tri-band beam $40; Mosley A-92-S (2 mtr) Beam 110' twin lead -$15; ASAHI-PENTAX 35mm, fl. 8-55mm, fl.8-85mm with cases $150; want Central Electronics 20A; WA4TNW 29482.

SWAN 240 TRANSCEIVER Swan AC and Mobile Power Supplies. $250. Excellent condition. David D. Kaufman, 9458 Loch Avon Dr. Pico Rivera CA 90660.

FOR SALE: Heathkit Mohawk receiver $100, DX-60 $50, and HG-10 $25, or $150 for all FOB Bakersfield CA. John Parker 5008 Greenbrier Ave. Bakersfield CA 93306.

TRANSISTOR PROJECTS: send for free list. EDI, 1918A 49th E. Palmetto FL 33561.

LIN AMP for Swan 250 with two 4 x 150 Complete Power Supply, instructions, etc. $125.00 WA0NAO, 7393 Flora, Maplewood MO 63143.

SWAN 250 complete with SKR-PS instructions, etc.$200.00 WA0NAO, 7393 Flora, Maplewood MO 63143.

430 MC RECEIVER or transceiver wanted, supereg preferred home made or mfg. Give price if in working order. Box 8352, Savanna GA 31402.

10 FOOT PARABOLIC DISHES—Spun Aluminum. Some in original crates. Frequency range 450 MHz to 8.5 GHz. No feeds available. Feeds available from the manufacturer or can be fabricated. $100. FOB Topeka FM Engineering, 3501 Croco Rd. Topeka KS 66605.

SOMERSET COUNTY HAMFEST The 5th SCARC Annual Hamfest will be held Sunday June 7 at the Casebeer Grove 4 miles north of Somerset, Pa. on US Route 219. Registration starts at noon. Rain or shine — Free tables indoors for swap-shop. Write K3YVS, 719 Division Street, Berlin PA 15530.

ROCHESTER, N.Y. is the location for the 37th Annual Western New York Hamfest and VHF Conference, the weekend of May 16th. Location is Bristol 50 Acres, Rte. 15 just south of Thruway Exit 46. Advance registration and banquet only $6.75. Advance sale closes May 9th. Send check to Western New York Hamfest, Box 1388, Rochester, N.Y. 14603. Activities start Friday night followed by full day of technical programming with outstanding speakers. Special activities include MARS, AREC, and QCWA meetings, YL program, code contests and huge flea market.

AUDIO BANDPASS FILTERS for improved receiving or phone patch. Top grade commercial units made by Stancor and UTC. Sharp cutoff below 300 Hz and above 3000 Hz. 600 Ohms in, 10K out, use them back to back for even better results or impedance match. 20 watts max. Postpaid 2 for $5.00. Charter Electronics Box 88, Gladwin MI 48624.

PRECISION TOROIDS, wound to mil spec on high grade tape cores. 1½ in. dia. not potted. Choice of 250, 500, 850, or 1000 MHy. $1.00 each or 6/$5 postpaid. Charter Electronics, Box 88, Gladwin MI 48624.

CHC — Certificate Haters Club.

This certificate is available to any amateur who sends a statement saying that he has never enjoyed receiving a certificate, that he hates certificates, and that should he ever by chance receive a certificate in the future he will hate it. Please include $1 to cover handling and mailing costs.

DXDC — DX Decade Club.

One hundred countries is a bit much for Novices, on six meters, on 160 meters, and other esoteric bands, so we have this certificate available for any amateur who furnishes QSLs proving contact with ten countries on the official WTW country list. A dollar bill should cover costs admirably.

WAZP—Worked All Zones Promised

Though interest in the Worked All Zones certificate has dwindled substantially in recent years, every now and then a DXer comes along who wants to try for this award. A statement to the effect that you promise to try and work all 40 zones plus $1 for handling and mailing will bring you this handsome certificate.

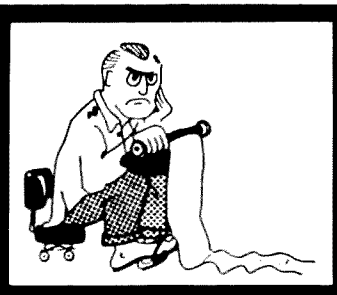
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73 MAGAZINE
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FCC Figures Revisited

EDITORIAL BY WAYNE GREEN

A little over a year ago (February and March 1969) I gave the graphs of the FCC figures on the total number of amateur licensees and the Extra and Advanced class licensees. At that time, with Incentive Licensing just a few months old, it was obvious that there was an increase in the Extra and Advanced class licenses, but we couldn't tell whether it was the start of an upward curve or not. The start was certainly extremely disappointing to anyone that expected some response from the amateurs to the new Incentive Licensing rules.

We have had an awful lot of talk about Incentive Licensing, but what is really happening? What has been the result of the November 1968 and November 1969 band changes as far as upgrading of licenses is concerned. . .and that is supposed to be what this is all about, is it not?

The figures in early 1969 seemed to indicate a massive rejection of the entire principle of Incentive Licensing. Beyond the oldtimers who were grandfathered into the Extra class license, only a handful bothered to go for Extra. . .or at least only a handful made it.

Now that the figures are in through February 1970, what do they show? Has that handful become a mob going for Extra? Were those few stragglers who went for the Advanced class license the forerunners of a horde to come? Is the principle of Incentive Licensing finally being accepted by the rank and file? Has QST managed to get this bitter pill swallowed?

Not exactly.

During February 1970 the FCC issued exactly 73 Extra class licenses. This compares with 278 the previous February. Perhaps this February was somehow different from last February. . .snow or something. . .so let's take an average of five months and see how that compares with a year ago. The average, centered on January 1969 (October through February) is 107 Extra class licenses a month. The year before it was 226, over double!

No wonder the FCC stopped the expansion of the Extra class CW bands!

What about the Advanced class license? Is that where the action is?

Not exactly. In the five months centered on December 1968 an average of 759 Advanced class licenses were issued. In May 1969 the average was down to 329, less than half! It has not picked up substantially since then. The February 1970 figure was under 400.

This should tend to cool off those enthusiasts who have been talking wishfully about the acceptance of Incentive Licensing. It has not been accepted. It *has* been rejected. Let's not let anyone try to fool us about this. Perhaps, now that the vote is in where it really shows, we can prod the FCC into some action to get things back where they were before and set up a more realistic program for encouraging amateurs to progress. The punishment type of incentive as proposed by the ARRL and put into law by the FCC under pressure from ARRL has been the biggest trauma ever to hit our hobby. Psychologically it was doomed to failure from the start. . .punishment as a means for forcing action never succeeds like rewards.

Perhaps it is about time to go back and do what should have been done in the first place. . . consult the amateurs as to what they think should be done. Few amateurs are not in agreement that we need some incentives to urge us to progress. Maybe it is time for the active amateurs to take a hand in their future instead of leaving it to a small unchosen few who have had little active ham experience in years to make the decisions for us from their ivory towers.

What can be done? Well, since you have no representation or lobby in Washington to speak for you, you have to speak for yourself. Get your club to send a petition to the FCC requesting a halt to the Incentive Licensing band allocations . . .get them back where they were in October 1968. Get as many members to sign this petition as you can and send it to the FCC. Be sure to double-space it when it is typed up and don't forget the lousy 14 copies (plus the original). You might make a 15th for me. . .and a 16th for QST. Have the original notarized and send the works to the Secretary of the FCC, Washington, D.C.

Once we get back where we were before this big ARRL production, we can start working on a reasonable incentive system that will reward instead of punish.

The FCC figures put the lie to ARRL's insistence that everything is really all okay and

that most amateurs are accepting Incentive Licensing with good grace and getting their higher grade license. They have tried to maintain the fiction that the opposition to this was by a handful of malcontents and rabblerousers. 73 Extra class licenses in February out of a pool of 130,000 General and Conditional licensees tells the story.

Bright Side. The total number of amateurs, which virtually stopped growing in 1963 (the time of the ARRL Incentive Licensing proposal), has been edging upward again. In 1967 it was down 2%, in 1968 it swung positive to about 0.01%, in 1969 it was up to 0.5% growth, and in 1970 it is up to 2.4%! This is not up to the 10–12% of the pre-1963 growth, but it is certainly encouraging.

FCC Railroading Fee Hike

The FCC announcement of the proposed license fee hikes reached 73 after the April issue had already gone to press. We did manage to quickly insert a little bit about it gleaned from a phone call, but not nearly enough to make it possible for amateurs to be fully informed and comment intelligently on the docket. The closing date for comments was set for April 10th, meaning that by the time we could present the entire docket in the May issue, the official deadline for comments would be long gone. I immediately sent in a petition to extend the closing date and it was quickly denied. For some reason the FCC wants this one to go through with as little opportunity for the amateurs to know what is happening as possible.

Docket 18802 proposes that the amateur radio license fees be increased from $4 to $9. The basic idea is to put the FCC on a cash basis, paying its way with license fees. While I like the idea of a government agency operating in the black, I am about as anxious to help pay for much of the FCC doings as I am to pay for that lovely war in Vietnam.

I can see where it might cost around $4 for the FCC to make up, print, administer, grade, and process a license application and issue the license, but I can't see it costing $9, even considering the inefficiency and waste of the government running the program instead of our ham clubs.

The $9 bite wouldn't be so bad for the older amateurs, fellows who are working and making a living, but it could be a severe blow for the young kids in school and could even prevent many of them from applying for a license. Since most fellows fail the exam the first time through, the bill would run a lot higher than $9. I seem to remember an FCC release which mentioned that it takes 2½ tries to pass the ham license, which would put the ticket around $20 for the first license. One of the last things we need now is a further discouragement for new licensees.

May I propose a compromise? I would be willing to go along with even the $9 fee if the FCC would waive the fee on the first license issued to each amateur. This would permit the youngsters to start out in amateur radio without being heavily penalized and then they would make up for the first free ride later on at renewal time or when they stepped up to a higher license. Presumably they would be in a better financial condition after five years than they would at first.

If you have any thoughts on the matter you had better send them in to the FCC immediately. Though the date for comments on 18802 is now past, I am reliably informed that they will accept comments and put them with the file until the Commission makes its decision. Head your letter as being comments on Docket 18802 and give all of your recommendations as well as your reasons for them. The additional 14 copies will help, if you have a copier handy. Even without, your letter may count. Send it to the FCC, Washington DC 20554.

Do We Need Representation?

Our ignoring of the problems of the ghettos resulted in an escalation of problems, not in their going away. Our ignoring of the growing problems in the schools has had a similar result. I wonder if we are going to continue trying to ignore the problems besetting amateur radio?

The FCC is about to more than double the license fee for us, is on the verge of passing new rules for FM repeaters which could virtually stop the growth of this phase of our hobby and prevent amateur satellite development, and has just slugged us with the most extensive revamping of our bands in the history of amateur radio. When are we going to stand up and say that things have gone far enough?

The blacks decided to do something about their problems. . .and have had success. The students have started making themselves heard . . .with success. You, the amateur who is being done in, have yet to speak out and make yourself heard. How long are you going to take it? Things don't have to go this way and you know it. As long as you continue to play the game with the same marked cards you are going to come out the loser.

We need representation in Washington and we need it right now and we need it badly. We need someone who can protect the interests and rights of radio amateurs. . .someone who can talk turkey with senators and congressmen. . .who can talk with the FCC staff and find out why we are getting dumped on and what can be done to stop it. We need someone who can talk with the military and get them to help us in our battles. They need us and should be reminded of this now and then. We do not have this now. . .we need it.

DX Pileups

An article by G3BID proposed that pileups "attract" and are self-inflating. Obviously he has something there. DXers tuning across the band listen carefully for pileups as a method of finding rare DX. Often they will leap into the pile

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without even knowing who they are calling. This comes out when they make the contact and have to ask in embarrassment for the call of the DX station they are working.

Pileups are caused by poor operating on the part of the DX operator. It is disappointing that so few DX operators avoid the time-consuming and frustrating pileup process. The system for getting the most contacts in the least time, using only one frequency and virtually eliminating pileups, is simple, but when was the last time you heard anyone using it?

Control of the situation is in the hands of the DX operator. Those wishing to contact him will follow his instructions as best they can in order to get that cherished contact. The op must be *absolutely inflexible*. He must set down the rules for getting through to him and then stick to them without exception. If he once breaks his own rules, then he has failed all of those who have been obeying them and they will have every reason to be resentful and even spiteful.

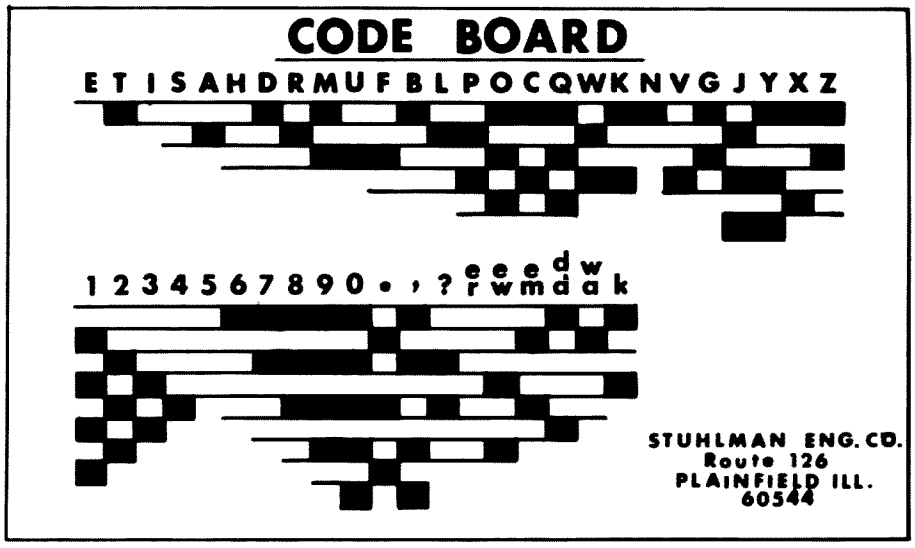
The DX operator should set down his rules and repeat them every few minutes for the newcomers. Rule number one is that all calls must be on the frequency of the DX operator. Rule two is that all calls must be just once, one five-second phonetic spelling of the call of the calling station and no wasting time by giving the call of the DX station. Rule three is that calls will come in the order specified by the DX operator, with no exceptions whatever. It might even bind the cheese better to announce that anyone calling out of order will be placed on a lid list and will be contacted after all others calling are worked.

The problem for the DX op is to get the call letters through the interference. If the calls are spread thin enough this is no problem. Let's say that the band is open to the U. S. and you are the DX op starting a series of contacts. It usually starts slowly with one sharp operator noticing your signal and calling you. When you finish a short contact with him, two or three are calling. You work them faster and by that time there are tail–enders, breakers, and every type of ogre known to the rare DX op. Now is the time to swing into contest style operating. Announce your rules. Then stand by for a specific call area. If the one call results in nothing but a mess, ask for WA1s. This will psychologically prevent W1s and K1s from calling you. If you ask for W1s, you will get all three prefixes. One WA1 should stand out enough to get some of the call. The fast breaks permit you to get this done very quickly. Work K1s next, then W1s. Finish up by asking for any other 1s such as hams from other areas operating "/1"; then you might ask for any DX calls with a 1 in them. Next start in on the 2s. You can check the 2s en masse first, then split them into WB2s, WA2s, K2s, and finally W2s. Don't forget to ask for DX 2s too – they will probably be there. If you forget them you will start hearing them breaking in and botching things up for you.

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The next time you hear some poor soul struggling with split frequency or tail enders, why not take the time to tell him how to operate. You would do the same for a lid in the U. S., wouldn't you?

The DX op should remember to pass along the QSL information every few minutes and to give his call frequently, phonetically. If things slow down a bit, it doesn't hurt to add a few comments about the country you are visiting for the assembled multitudes.

One other benefit of this super-fast system is that even the low-power stations will be able to get through since you get right down to complete quiet at the end of working each call area. The op will find himself working even mobiles and transistor rigs, making it more fun for all concerned.

European ops can be handled in exactly the same way. Split them up into countries and then, if required, prefixes. With any kind of opening the DLs and SMs will have to be cut very thin to be sorted out.

The split-frequency rubbish was perpetuated all too long because one well known DXer used it. It now appears that he used it because it permitted him to avoid contact with some ops rather than because it was fast. Let's bury this wasteful relic of the past.

The Post Office Mess

Isn't it more than strange that in 1970 we are sending letters just about the same as they were sent in colonial times? In this electronic age it is nonsense for us to have to write on a piece of paper and then send that piece of paper to someone else for them to get the message.

Sure, there are some things that go well on paper. . .legal items such as wills, mortgages, etc., need some permanence, but most of our communications are read and then thrown out. Or, if they are kept, they take up a lot of filing space.

At 73, we get some 200 subscriptions a day by mail. Two hundred envelopes, two hundred letters and two hundred checks. Add to this another fifty or so letters to the editor and other items. Over 80% of the mail in our country is

(continued on page 111)



Ironic as it may seem, I think the biggest stumbling block to the advancement of amateur radio is a lack of communication between the people who make the rules and the people who follow them. Consider that infamous anti-repeater docket, the product of a small group of nervous and suspicious individuals within the FCC.

There are restrictions posed by Docket 18803 that can be explained with no rationalization other than the simple fact that the FCC is worried that amateurs will misuse spectrum, thereby creating more headaches for the Commission by virtue of a possible rash of intra-fraternity complaints of interference and the like. I suspect Docket 18803 is geared first to forestall any such misuse and second to keep the ham radio operation within the realm of the Commission's archaic understanding.

The plain truth is that the FCC has precious little understanding of ham radio. This fact casts no aspersions of ineptness on the good people in Washington, for they certainly mean well. But consider the breadth of their jurisdiction: the billion-dollar broadcasting market, the interstate use of phone lines, the pathetically misused citizens' band, the pay-TV snake barrel, the crowded commercial, industrial, and governmental spectra. Is it any wonder the handful of men in Washington have no real feel for what's doing with the comparatively trouble-free minority group of ham radio?

Paradoxical, yes, but fact: Those well meaning fellows in Washington are painfully ignorant as to the capabilities and limitations of radio as we know it. Attesting to this is the FCC's answer to Wayne Green's recent request for an extension to the deadline for filing comments about the license fee increase. Wayne's reasoning was that more time was needed to disseminate the information. The ham journals needed time to publicize and editorialize; ham groups needed time to plan meetings and have discussions before filing comments. Reasonable? To you and to me, yes – but not to the FCC. The FCC told Wayne that amateurs in particular needed time the least, since hams all have communications capability.

Obviously, the FCC has the idea that if one ham makes an on-the-air announcement, all others will immediately get the word. (And I guess most of us thought that way before we became hams.) The unfortunate thing is, however, that the FCC's official reason was less than no reason at all, and served only to illustrate the communications breakdown between the rule-passers and the rule-followers.

I must admit, albeit reluctantly, that the communications gap is not strictly limited to failings on the part of the Washington bunch. I myself was guilty of misinterpreting when, in a rush to make deadline for the last issue of 73, I published opinions on a docket I hadn't yet seen. I based my comments on a verbal description of Docket 18803, which resulted in my erroneous assumption that remote operation would be illegal (because of the crossband restrictions). Everett Henry called me from FCC headquarters shortly after the magazine came out to set me straight.

I'm confident the FCC doesn't trust us. The people in Washington are wary of saying yes to anything because they're afraid of unleashing another holocaust like CB. As a result, the FCC undoubtedly pores over every petition about repeaters with exasperating caution.

But are we any better? I traveled several hundred miles a few weeks ago to attend one of the many special meetings that are taking place across the country because of Docket 18803. The purpose of the meeting was to examine the FCC proposal, determine what action to take, and make a decision as to how best to act – collectively or individually. *We spent more than three hours discussing such simple trivia as how the proposed rules were worded!* More than one of those amateurs attending the meeting was convinced that the FCC was trying to nail us with subtle wordings. And the result was that we spent our time trying to interpret sentences whose *intent* was pretty plain at a glance. We got nowhere and proved nothing except the fact that we don't trust the FCC, either.

Now, more than ever, I wish I were a sharp attorney. I'd like to present our case intelligently before the FCC, then listen to comments in opposition. I think I'd point out that ham radio needs policing the least of any radio service. Yes, I know the FCC has probably received more complaints about repeaters than any other ham mode – but repeaters have never been legally recognized, so they have always been a subject of controversy. But the real case for repeaters is the case for public interest, convenience, and necessity. More than any other aspect of our hobby, repeaters fill this requirement. Rare is the repeater that has no public service ties. And more and more common is the repeater that is relied upon by local civil defense and other emergency organizations.

I would appeal to the FCC to put 18803 in abeyance, and adopt Docket 1542 as an interim measure, in the same manner as the government of our Canadian neighbors has done. Let us prove our worth. Let us have the opportunity to do what we're licensed for – to serve our purpose to the best interest of the public. There is no clear and immediate need for a tight set of restrictions. Even the FCC can see where the proposed restrictions are detrimental to public interest. What we really need is relaxed restraints so we can develop and grow, and prove even more valuable to the communities in which our repeaters are situated.

. . . K6MVH ■

I find it incomprehensible, listening to the remarks of some hams, otherwise quite placid and mild mannered, when the subject gets around to fellows who wear their hair longer than most of us do. There would appear to be a hidden spring of sadism which wells up to the surface and overflows, and it requires very little stimulus to start this unreasoning thing a-going. But after all, let's face it: long hair does not a "hippie" make.

A certain party I've always liked was heard to expound on this subject. "If I'd had a pair of scissors in my pocket, I'd have given some of those guys a haircut!" Now, of course, this is silly, because a chap's haircut is no index to his political persuasion or anything else. If you doubt that, just turn your memory backward and visualize the late Senator Everett McKinley Dirksen. If ever there was a man with a more disreputable looking mop of kapok on his noggin, I'd like to know who. Yet no one ever faulted old Ev. Leastwise, not about his leonine tonsure. Matter of fact, that unruly hairdo was one of his most notable characteristics, second only to the mellifluous foghorn, that voice with which he spoke the best English extant. . .unique and famous the world over.



On the other hand, in the first days of the Russian Revolution every Bolshevik in good standing shaved his pate clean. I presume that this was proof positive that he had undergone the delousing process regarded as *de rigueur* at that time in that unhappy land. So far as I know (and I couldn't care less) they still need the delousing!

You cannot tell anything about someone's political or social persuasions on the strength of physical appearance. Unfortunately there are some reds who wear the cloth. And there are Cosa Nostra torpedoes who look like bankers and members of the Union League. And I remember a highly successful female film star who made the list of the ten best dressed women several times. Actually, she needed a bath so badly she stank to high heaven!

Now that I reflect upon it, I don't think my friend would really attack anyone with a pair of scissors. As I visualize his all-too-evident head full of pink, shiny skin, drawn as tightly as a snaredrum head, I think it was probably just a case of pure green-eyed envy.

That's all.

Nobody asked me, but . . .

. . . Why do some would-be "control stations" try to set up net-style operations during ordinary, roundtable ragchews? They grandiloquently announce, "John, you give it to Joe. Joe will turn it over to George; George, you pass it to Pete; Pete will give it to Charlie, and Charlie will turn it back over to me." If they're so all-fired anxious to act like traffic cops, why don't they join the police department?

. . . Why is it that when the band is almost devoid of activity, and you're having a nice quiet chat with an old friend, some thoughtless creep starts counting, "One, two, three, four, four, three, two, one. Testing, testing, testing," right on your frequency, or even worse, 500 Hz away? Why is it?

. . . How come some guy in contact with a rare DX station will start to describe his shack, the color of his wallpaper, the ages of all his six kids, his wife's operation, his bursitis, why he switched from vox back to push-to-talk, and who was the King of Albania when he got his first license? And how come this always happens when there are 479 other guys trying to get a contact, especially when the signals are starting to fade into the rising noise level. How come?

New Math

As a public service, and to uphold the dignity of us fuddy-duddies of the older, more benighted generation, I'd like to say a few words about the so-called "new math" that some of the kids are bringing home from school these days. It is disconcerting, doubtless, to hear seven- and eight-year-old tykes uttering mystifying and formidable terms such as "sets, subsets, commutative and associative properties" and the like. In our day, and I blush to admit it, plain old plus and minus were obstacles enough, and I distinctly recall that it took me weeks to learn my multiplication tables.

The essential thing about the new math is that it seeks to be precise, and also avoids the use of misleading inaccuracies of the past. I remember being told, "You can't subtract 9 from 7," for example, and then making the discovery that I could indeed subtract, obtaining minus 2 as the answer. Nowadays kids are taught the essential structure of the subject. . .the why, rather than the how. . .through plane geometry, algebra, number lines, binary arithmetic and sets. They

are also being introduced to analytic geometry, probability, and Boolean algebra. . .all of which were previously restricted to college level courses.

The new teaching, called the discovery method, is worlds removed from the old teaching by rote. By means of a sort of Socratic question-posing technique, children are steered into investigating for themselves the world of numbers. The premise is that what is absorbing and intellectually intriguing is fun, and consequently learned more quickly and more lastingly.

Many parents, unwilling to relinquish the old methods which they learned in school, are finding it difficult to catch on to the new math. Because one of the most important roles of father and mother continues, in spite of changes in attitudes, to be the preservation of a sense of respect for elders in their offspring, this is getting to be a problem. The kids cannot seem to generate much respect for elders who cannot seem to grasp intellectual concepts which they themselves find logical and understandable.

There is an interesting little book, published by the American Book Company, entitled "What About This Modern Mathematics Business?" (A Handbook for Parents.) This book, simply written, explains in clear terms the material which is covered in these new school programs. I recommend it to you earnestly if you are puzzled about this subject.

After all, what are you going to tell your youngster when he asks, "Gee, Dad, will you help me make a Mobius Strip to take to class tomorrow," or, "Say, Mom, what's the difference between the decimal, duodecimal, and binary numeration systems?"

Atrophy

I write a semiweekly column for a suburban newspaper in the area where I live. In casting about for subject matter (I am not restricted in any way), it struck me that I might discuss ham radio. In my column I pointed out that this would be a splendid opportunity for channeling the energies of youngsters in a meaningful and constructive way. I pointed out that there were no acid-heads or glue sniffers. . .no hubcap thieves or child molesters. . .and probably very few radicals or revolutionaries in ham radio.

I also pointed out that apart from the enjoyable aspects of the hobby and the opportunities to perform public services in many ways, participation could also unlock the doors to very rewarding careers in electronics. I closed the column by inviting inquiries, and stated that I would refer all such to regional and local amateur radio clubs, so that the matter of license and equipment could be dealt with.

As a result of the appearance of this column I received several dozen replies. There appeared to be an enthusiastic body of area residents, most interested in becoming involved. This included many adult persons in addition to young people. In three instances the queries involved entire families, both parents and children. This large response was extremely gratifying, and I was sure that in a short period there would be some new amateurs in this area, a most desirable development from every standpoint.

I am chagrined to have to report that I was not able to find too much club activity here. The nearest club to me has been *hors de combat* for the past two or three years. There do not appear to be any truly active radio clubs anywhere in the immediate vicinity, outside of some which are specifically slanted toward individual ham activities such as DX or VHF. Consequently, I have had to combine my own personal efforts with those of some ham friends, in order to get these folks oriented, trained, licensed, and equipped. I have not been able to find a single active radio club functioning here. This is a sorry state of affairs, particularly since there was a great deal of club activity hereabouts in prior years.

The high schools, a natural place for the formation and growth of such clubs, are almost totally devoid of any interest in the matter. One of the main reasons for this is the failure of school boards to provide any funds for this type of activity, and, since the budgets do not call for any expenditures in this area, there are few teacher-hams who could be expected to stand the cost personally, much as they would like to do so. It is unfortunate that while there are always enough funds to purchase footballs, twirling batons and hockey pucks, somehow the schools do not seem able to buy the most inexpensive pieces of used radio gear, so that radio clubs can be activated where they might do some good.

I should like to urge all the readers of Leaky Lines who live in communities where a similar situation exists to instigate programs of their own, in order to awaken interest in amateur radio among area residents. Where the school boards appear to be unenthusiastic in their response to the idea, public demand for such programs may possibly inspire a change in direction. I am confident that there is not a science department in a single school which does not include a teacher who would be willing to assume the trusteeship or leadership of a ham radio club. Offer your services and make yourself available to such people so that your neighborhood school may become a spawning ground for future hams. If we address our energies to such projects there is no doubt that many clubs can be activated.

We all owe a debt to this hobby we love so well. I suggest that one of the most concrete ways in which we can repay it is to see that our enthusiasm is passed along to the youth. If we can institute and maintain a viable, ongoing process of ham recruitment, we will not only be supplying our hobby with a vital flow of new blood, but we will be contributing toward our nation's health by helping to provide constructive, positive and meaningful channels of activity for our youngsters. What could be more important than that?

. . . K2AGZ ■

SPECIAL REPORT

73 Comments on FCC's Proposed Repeater Rules

Many of us by now have had the opportunity to study Docket 18803 carefully. For the benefit of those who have not, I think it is safe to say that this proposal is the most important since incentive licensing, and more devastating to the future of VHF amateur radio than any rule change bid in our history. For repeaters, the proposal changes are stiflingly restrictive and growth-stopping. For remote operation, the proposed rules are disastrous. With these rules, there can be no satellite translators, no mobile remote control operation, no city-to-city links, no cross-country systems. Docket 18803 spells instant death for remote operation as we know it, and imposes complex repeater hardships – and this is no exaggeration. Every radio amateur – VHF'er or low-band operator, repeater owner or not, remote devotee or CW enthusiast – owes it to ham radio to do everything in his power to stop this proposal from getting passed. To do this, here is what *you must* do: Read the FCC-proposed rule changes reprinted here, then write your comments. Send the original and 14 copies of your comments to the FCC in Washington, D.C. *before May 15.* This is absolutely essential. You *must send all 15 copies before May 15.*

The FCC Proposal (Docket 18803 Appendix) is printed in italics below. The comments of the 73 editorial staff are incorporated in close-spaced bold-face type. Your comments may or may not coincide with those of 73. At any rate, you have the chance to see what we think of each item in the proposed rule changes. Make your own comments independently if you like; or, if you feel as we do, tear our comments out, sign it, then make 14 copies and send the whole works to Washington.

If you're involved in a repeater that has public service ties, get affidavits and supporting documentation from your local government authorities. Remember – they, too, have the right to make comments, since their operations are directly affected by the proposed changes, and they do represent the public, whose interest is supposed to be served by amateur radio.

DOCKET 18803 APPENDIX
RULE CHANGE RECOMMENDATIONS OF FCC
(with editorial comments in bold type)

1. In § 97.3, a new paragraph (i) is added to read as follows:

§ 97.3 Definitions

(i) Amateur Repeater Station. An amateur station at a specified fixed location used to automatically retransmit signals of other amateur stations.

2. Section 97.41 is amended by adding a new paragraph (b) as set forth below, and redesignating former paragraphs (b) and (c) as (c) and (d).

§ 97.41 Application for station license.

(b) Each application for a remotely controlled station shall be filed on FCC Form 610 or FCC Form 610-B, as appropriate, and must include a supplementary statement giving the address of the remote control point and indicating whether control will be by wire or radio. If remote control is by radio, complete information must be furnished showing how the transmitter is controlled and what means will be used to prevent unauthorized operation of the transmitter. Data on control frequencies, the function of all relays, timing devices used for control, directional transmitting and receiving antennas in the control system, and other pertinent details must be included.

3. A new § 97.42 is added to read as follows:

§ 97.42 Station location.

Every station must have a fixed transmitter location. Only one fixed transmitter location, which will be designated on the station license, will be authorized unless the station is authorized to be operated by remote control.

4. Present § 97.43 is deleted and new § 97.43 is added to read as follows:

Amateur Remote Stations

§ 97.43 Remote Control of an Amateur Station.

(a) Remote control of an amateur station other than an Amateur Repeater Station from a point or points specified on the station license may be authorized provided:

(1) The remote transmitter is so installed and protected that it is inaccessible to unauthorized persons.

(2) That in addition to complying with § 97.85, a photocopy of the Amateur Station license is posted in a conspicuous place at the remote transmitter location.

(3) The emissions of the transmitter are continuously monitored at the control point.

(4) The radiation from the transmitter can be immediately suspended from the control point when there is any deviation from the terms of the station license or the requirements of this part.

(5) The station is so designed and installed that the transmitter can be activated only from the authorized fixed control point.

Such exclusive activation restricts the operation of a remotely controlled station to the detriment of the public interest, convenience, and necessity. No mobiles, for example, would be allowed to access the remote station, which is at present perhaps the most valuable type of installation for public service applications, would be restricted in such a manner that it would be virtually worthless for all uses except the relaying of signals to and from the control operator's base.

One life—at least—was saved already because of an amateur's ability to access his remote transmitter and phone patch from his car. On a stretch of freeway near Los Angeles, a motorcycle officer had a heart attack and spilled. Motorists stopped but no one could help. Don Milbury W6YAN didn't even stop. He accessed his remote autopatch as he passed the scene, and called an ambulance and the local authorities. The policeman might have died without the prompt medical aid that came as a direct result of Don's call. Amateur radio paid its way that day, and no one could say that Don Milbury's brand of radio is not in the best public interest. If this part of the FCC proposal gets through, operation of a remote station from a car will not be legal.

On another occasion, two amateurs in Pomona, California saw a hit-and-run accident, and telephoned the police from their car using the remote control facilities of K6MVH. The two hams followed the suspect car while they kept up a running conversation with the police dispatcher, who radioed update location data to patrol vehicles in the vicinity. Within minutes, the suspect vehicle was intercepted. The local police were impressed with the hams' communications capability. It is doubtful that this local government considers amateur radio to be a TVI-generating nuisance, as so many others do.

As a suggested alternative rule change for the above-proposed item, how about this:

(5) The station is so designed and installed that master control can always be effected from the fixed control point, and access from the fixed control point shall at all times be capable of overriding all other input signals.

This suggested alternative proposal leaves the door open to operate and control a remote station from a hand-held, portable, or mobile unit, as long as an authorized monitor has the capability of exercising master control from the fixed station.

(6) That if remote control is by radio, the control link is direct, without intermediate relay.

Here, again, is a rule portion that does not appear to be in the public interest. *Master* control of the remote transmitter, of course, *should* be "direct" without intermediary relay. But there should be no rule against indirect control as long as the direct control is maintained from the fixed site. Many remotely controlled stations are situated in such a manner that "direct" control from a low-power station is impossible because of distances, terrain, etc. To circumvent the problems, an intermediary station is set up so that user stations can transmit signals that can be relayed to the remote transmitter. Back-to-back repeater stations are examples of indirect control of a remote facility; they allow installation of phone patches even when there are no phone facilities at the basic remote location. They allow range extension when the users live out of the area where most of the FM action is taking place. In addition, they offer the only means whereby users of one remotely

controlled facility may access and command another such station, situated perhaps many miles from the first site.

In California, New England, and Nevada, for example, experiments have been performed and systems are currently being built that allows repeater groups to access the repeater facilities of other repeater groups by mutual consent. The UHF control facilities for the WB6SLR remote station in California could be used to interrogate the control system for the K7TDQ remote station in Las Vegas. If K7TDQ is willing to allow his repeater to be an input/output terminal, he could electrically command his system to respond to the control signals of the WB6SLR machine in California. The result is a Los Angeles to Las Vegas repeater system interconnected by a controllable 450 MHz link.

Similar cooperative efforts have taken place along the eastern seaboard when Gordon Pugh K2GHR exercised control of several repeaters in New England and Canada from his own remotely controlled station.

Repeater expansion along the lines of metropolitan interconnections – currently being planned between northern and southern cities of California, between Tulsa and Wichita, San Diego and Phoenix, Los Angeles and Las Vegas, and perhaps 50 other places in the country – cannot take place without allowing "indirect" control of a remotely situated station.

(7) That if remote control is by radio, the control transmitters operate on frequencies within a band above 220 Mc/s.

(8) That if remote control is by radio, a timer is provided to automatically limit transmission to a period of three minutes in the event of failure of the radio control link, capture of the control receiver by an undesired signal, or other technical malfunction.

Amateur Repeater Stations

(b)Remote control of an Amateur Repeater Station may be authorized provided:

(1) The installation and operation of the station complies with paragraph (a) of this section.

(2) The station is provided with an automatic timer to limit a single uninterrupted transmission to a period of not more than three minutes. This circuit may be so designed that it will automatically reset but will not permit use of the transmitter until receipt of a properly coded signal.

The last sentence in this segment should be replaced with: "This circuit may be so designed that it will be automatically reset but will not permit reactivation of the repeater until receipt of a properly coded signal." The wording differences between this and that proposed by the FCC are quite subtle, but the reason will be clear when the comments to (4) below are understood.

(3) The station is so designed and installed that overriding control of the station is maintained from an authorized remote control point.

(4) The station is so designed and installed that the transmitter can be used only upon receipt of a coded tone signal after the transmitter has been activated from the control point.

There are two major types of coded repeater control in very common use, both of which offer the protection from inadvertent interference that is the purpose of such control methods. The first type of control is "tone burst entry," where a coded tone is required of each repeater user at every transmission in order for his signals to be repeated. The second type, single-tone activation, is commonly known

as "whistle-on," and allows the repeater to be activated for uncoded carrier operation when the user whistles on the input frequency. In the whistle-on system, the repeater continues to operate on a carrier-operated basis as long as the repeater is in constant use. When a short time goes by with no input signals, the repeater automatically deactivates, and must be "whistled on" before it can be again activated. The rule as proposed by the FCC does not provide for this very functional form of subcontrol, and places an undue burden on all repeater operators to the effect that ALL users must equip their units with tone generators. The intent of the rule can be satisfied without the necessity for all operators installing tone-burst equipment if the rule in question were to be modified as follows:

> The station is so designed and installed that the repeater can be used only upon receipt of a coded tone signal after the transmitter has been activated from the control point; or, in the case of a whistle-on tone system, the repeater can be energized for carier operation provided that a means is incorporated for automatically deactivating the repeater within 3 minutes after the last signal is received. Reactivation after this period can be achieved with a tone from the repeater input frequency only if the repeater has been properly activated from the control point.

(5) The station is so designed and installed that the transmitter will be silenced within five seconds after cessation of the output of its associated receiver.

5. In § 97.61, the introductory text of paragraph (a) is amended, and a new paragraph (c) is added to read as follows:

§ 97.61 Authorized frequencies and types of emissions.

(a) Following are the frequency bands and associated emissions available to amateur stations, other than Amateur Repeater Stations, subject to the limitations stated in paragraph (b) of this section and § 97.65. Frequency bands available to Amateur Repeater Stations are shown in paragraph (c) of this section.

(c) Amateur Repeater Stations must receive and transmit in the same frequency band. Simultaneous transmission in two or more frequency bands is not permitted. The following frequency bands and the emissions authorized in those bands in paragraph (a) of this section are available for Amateur Repeater Stations:

52.50 - 52.70 53.00 - 53.20

Input (Receiving) Mc/s	*Output (Transmitting) Mc/s*
52.50 - 52.70	*53.00 - 53.20*
146.30 - 146.60	*146.90 - 147.20*
223.10 - 223.30	*224.10 - 224.30*
447.70 - 448.90	*449.10 - 449.30*

Any amateur frequency above 1215 Mc/s

The intent of this part of the proposal is to lessen the congestion caused by multiple transmissions of repeaters and to minimize the interference caused by crossband operation, where monitoring of the output before transmission is difficult and impracticable. The outlawing of 6-to-2-meter systems seems reasonable, because both bands are active, often crowded, and are in general use by amateurs using a variety of modes.

But who could deny the attributes of a crossband system between 2 meters and 220 MHz, or between 6 or 2 meters and any of the UHF bands, or between one UHF band and another? Is this not the next logical step in amateur repeaters? And is this not the only practicable method by which amateur orbiting satellite translators and repeaters can evolve?

In the interest of furthering the development and natural growth of amateur radio, there should be no restrictions between crossbanding on these higher frequencies, where the bulk of the activity is already provided by the individuals who inhabit the spectrum for the sole purpose of exploring and exploiting the capabilities of advanced communication forms.

The frequency restrictions of the above subband allocations are also unduly restrictive. Not only would these allocations render a large number of existing repeaters illegal, but they pose problems to the repeater users that are only questionably solvable within the existing state of the art (such as the narrow spread in the 450 MHz region).

There are obvious advantages to restricting repeaters to specific portions of the spectrum, and virtually every VHF operator knows this; for this reason, amateur 2 meter FM operators — including repeater owners and users — have unanimously agreed to populate only frequencies above 146.04 MHz, and then only those frequencies that are spaced at multiples of 30 kHz from one another. In highly congested areas where there is an abundance of FM activity, operators have made unwritten agreements to reduce deviation levels to ±5 kHz at least on alternate channels, and in many cases they have reduced deviation to narrowband standards on all FM channels. Since channelized operation is universally accepted in the United States (and Canada), there would seem little need to establish discrete band portions for transmitting and receiving. Rather, it would seem in the best public interest as well as in the interest of amateur radio, to allow FM repeaters to be established on existing channels, depending on the activity, operating conditions, and individual requirements of the areas where the repeaters are to be used. In some cases, the repeater input should be higher in frequency than the output; in others, the reverse would be more locally suitable. And in some instances, as in separated sites, the transmitting and receiving portions of the repeater could best be placed on the same frequency (as has been done successfully in several installations).

6. Section 97.67 is revised to read as follows:

§ 97.67 Maximum authorized transmitter power.

(a) Transmitter power is the d.c. power input to the final r.f. amplifier. If the final amplifier is of the r.f. grounded-grid of r.f. grounded-base type, the transmitter power also shall include the d.c. power input to the stage which immediately precedes the final r.f. amplifier.

(b) Except as limited by §97.61 (b) transmitter power shall not exceed:

(1) 600 watts for transmitters used at Amateur Repeater Stations.

Since the difference between 600W and the 900W maximum legal limit of remotely operated transmitters represents but a barely noticeable amount (less than 2 dB), little is to be gained by this restriction. An amateur repeater should be allowed to operate with the same power restrictions faced by other amateur stations.

(2) Two kilowatts for single sideband radiotelephone transmitters and other amplitude modulated radiotelephone transmitters using reduced, suppressed, or controller carrier when measured during maximum peaks of modulation;

(3) One kilowatt for all transmitters other than those covered by subparagraphs (1) and (2) of this paragraph.

(c) Equipment capable of operation with transmitter power in excess of 90% of any applicable power limitation shall have installed a means for accurately measuring transmitter power.

7. Section 97.79 is revised to read as follows:

§ 97.79 Operator Requirements.

(a) An amateur station may be operated only by a person holding a valid amateur operator license issued by the Federal Communications Commission and only in the manner and to the extent provided by the class of license held by the operator or the station licensee, including the trustee of a club station, whichever is the lesser.

(b) The licensed operator required by paragraph (a) of this section must be on duty at the transmitter location or at an authorized control point.

(c) An amateur station licensed as a military recreational station may be operated only in the manner and to the extent provided by the class of amateur license held by the person operating the station.

(d) When an amateur station is used for telephony or radioprinter transmissions, any person may transmit by voice or teleprinter, provided a licensed amateur operator is present at the operating position, continuously monitoring the transmissions and maintaining supervisory control of the station, including turning the carrier on and off for each transmission and signing the station off after communication with each station has been completed.

8. In § 97.87, new paragraphs (e) through (h) are added to read as follows:

§ 97.87 Station identification.

(e) In lieu of the requirements of paragraph (a) of this section, an Amateur Repeater Station may be automatically identified by radiotelegraphy at intervals not to exceed three minutes by keying on audio tone superimposed on the voice transmissions. The code speed shall not exceed 20 words per minute, and the modulation level shall be sufficient to be readable through the voice transmissions.

This should be modified to permit automatic identification by telegraphy or recorded voice.

(f) A station licensed to an individual may be identified by its assigned call only when operated by or under the immediate supervision of the station licensee. If the station licensee, who is the owner of the equipment, is not present, the operator must identify his transmissions by using his own call sign with the appropriate portable indicator.

Should also state: An Amateur Repeater Station will be identified only by its designated call regardless of which authorized control licensee is monitoring from an authorized control point.

(g) A club station may be identified by its assigned call only when operated under the supervision of the trustee or an authorized club member.

(h) A military recreation station may be identified by its assigned call only when operated by a member of the Armed Forces of the United States who holds a valid amateur operator license.

9. Section 97.89 is amended to read as follows:

§ 97.89 Points of communication.

(a) Amateur stations may communicate with:

(1) Other amateur stations.

(2) In emergencies or for test purposes, and on a temporary basis, with stations in other services licensed by the Commission and with United States government stations.

(3) Any station, other than an amateur station, which has been authorized to communicate with amateur stations.

(b) Notwithstanding the provisions of paragraph (a) of this section, an Amateur Repeater Station shall not repeat the transmissions of another Amateur Repeater Station.

It is absolutely essential to the growth and technological development of UHF and VHF amateur radio that such restrictions are not imposed. Dual repeaters are invaluable for some applications, such as public service functions outside the area normally served by a repeater.

As an example, the Wichita repeater is heavily depended on by the local government to provide early warning for maximum evacuation effectiveness. Like any other repeater group, the Wichita repeater users have mobile units and hand-held transceivers, which are used in conjunction with the repeater to provide an effective communications system. But what happens when the alert is out of the area of immediate coverage of the repeater? With the FCC restriction of no multiple repeaters, civil defense usefulness suffers, because the mobiles and hand-held units of the group are worthless without the repeater – the heart of the communications system.

On the other hand, if multiple repeaters were not illegal, the repeater crew could take a portable UHF repeater to the scene to act as an intermediary system, extending the range of all low-power units so that the immovable repeater in Wichita could still be used as if the disaster point were actually in Wichita. The intermediary repeater could be no more than a temporary setup designed to operate from emergency power or from the power source of an automobile. This is how such a system works:

Hand-held units transmit on 146.34 MHz and receive on 146.94 MHz, frequencies compatible with the permanent repeater. The intermediary repeater receives on 146.34 and retransmits on the UHF control frequency for the permanent repeater. The control receiver at the permanent site relays the UHF signal to 146.94 and to another frequency in the UHF range. The intermediary repeater accepts the UHF signal and retransmits to 146.94, thereby allowing all low-power user stations to communicate through the permanent repeater by virtue of the dual relay.

Interlinking of repeaters is a vital step in VHF progress, and is one of the most attractive features we have to offer municipalities when we try to show them our communications potential. Using a multiple repeater system, it is now within the state of the art to set up a system of links so that user stations in one city could actually select, via a special access link, repeater interconnections in other cities. With the advent of communications satellites, UHF dial-a-city could become a very common practice – and it could be designed so as to be completely compatible with existing systems on a noninterference basis.

The proposed rule stated in (b) above should be reworded as follows:

Notwithstanding the provisions of paragraph (a) of this section, an Amateur Repeater Station shall not repeat the transmissions of another Amateur Repeater Station *except by mutual consent of the responsible principals of all repeaters to be affected by such a multiple relay.*

10. Section 97.103 is revised to read as follows:

§ 97.103 Station log.

(a) Each licensee of a station other than an Amateur Repeater Station shall keep a log of station operation which shall include the following:

(1) Except when operating mobile, the date and time of each transmission or the beginning and end of a series of transmissions.

(2) When operating mobile, the date and time station operation commences and ends.

(3) Call sign of the station called.

(4) If the transmissions are made through a repeater station, the call sign of the repeater.

(5) The signature of each licensed operator who operates the transmitter from the transmitter location or control point and the date and time of such operation.

(6) The name of any person other than the operator who directly or by recording transmits by voice or transmits by radio teleprinter.

(7) The input power to the transmitter.

(8) The frequency band or subband used.

(9) The type of emission used.

(10) The station location.

(11) If record messages are handled, a copy of each message sent and received shall be entered in the station log or retained on file for at least one year.

(b) The licensee of an Amateur Repeater Station shall keep a log of operation which shall include the following:

(1) The date and time station operation commences and ends.

To avoid misunderstanding, this should state ". . .the date and time repeater is placed in service and is accessible by user stations who comply with access requirements."

(2) The entries specified in subparagraphs (5), (7), (8), (9), and (10) of paragraph (a) of this section.

(3) A record of all installation, service, or maintenance work performed which may affect the proper operation of the station.

(4) The entry required by subparagraph (3) of this paragraph shall be made, signed, and dated by the licensed amateur operator who supervised or performed the work.

(c) The entries required by subparagraphs (5), (7), (8), (9), and (10) of paragraph (a) of this section need only be entered once until there is a change in the required entry.

11. In § 97.193, the introductory text of paragraph (a) is amended, and a new paragraph (e) is added to read as follows:

§ 97.193 Frequencies available.

(a) Except as provided in paragraph (e) of this section, the following frequencies and frequency bands and associated emissions are available on a non-exclusive basis to the indicated classes of stations or units of such stations in the Radio Amateur Civil Emergency Service.

There should be no subband restrictions above 51 MHz.

(e) A repeater in the Radio Amateur Civil Emergency Service may operate on any frequency and associated emission above 50 Mc/s listed in paragraph (a) of this section.

There should be no subband restrictions above 51 MHz.

END

WHAT WILL BECOME OF CW?

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If you look all the way back to the beginning of ham radio and then trace its development up to the present day, you will see some very interesting trends. For purely academic reasons it is interesting to see where we have been. It's like studying history. In addition, by noting the various trends that have occurred, we may be able to predict where we are going. I think that one of the most interesting trends to look at is the use of the various modes like CW, AM, SSB, and RTTY. Statistics are hard to come by here to verify these trends, but I believe we can still make some general and useful observations without them. One particularly interesting phase of this is the history of CW. Let's take a look at the mode trends over the years to see if we can predict what will happen to CW.

When ham radio first began, all we had was CW, first by spark then by normal means as we know it today. As the technology of radio and electronics developed, we soon had radiotelephone by amplitude modulation. The convenience of voice communications made AM popular among hams even though it was more expensive to use, would cover less distance, and was more succeptible to noise. FM came along soon after; it too gained some followers. These gains in radiotelephone work were made at the expense of CW. Those operators that used to work CW, were now working phone or some of both. So as the years passed and radiotelephone became more widely used, CW activity decreased.

I believe it is safe to say that ever since ham radio began, there has been a continued decrease in the use of CW. The major reason for this is simply the continued and increased use of radiotelephone techniques as they are introduced or become more perfected. The introduction and rapid increase in the use of SSB no doubt has taken its toll of CW operators as well (AM operators too for that matter). The equipment manufacturers have helped by making many reasonably priced radiotelephone transceivers, some of which have absolutely no provision for CW operation. That's progress, brother.

There are also other factors that have no doubt influenced the trend of decreased CW activity. For example, in the early fifties the FCC did away with the "Class A" license phone privileges and opened the 75 and 20 meter phone bands to all amateurs. This seemed to have an almost immediate effect of increasing phone operation and correspondingly decreasing CW activity. The increased use of the VHF and UHF bands has probably caused a similar but rather indirect decrease in CW work. As more hams go to these higher frequencies, CW activity tends to decrease. Who uses CW on the VHF and UHF bands anyway?

By just listening to the various CW bands you certainly wouldn't think that CW activity has decreased much. But the somewhat overcrowded conditions are the result of an increase in the total ham population. CW activity as a whole has increased because the total number of hams has increased, but *percentagewise* it has decreased. Today CW is probably in the 30 to 40% usage bracket while phone is in the 40 to 50% range. The total doesn't add up to 100% because some hams use both modes, of course. This overlap plus some of the special modes like TV, RTTY, pulse, etc. make up the difference.

Having noted the trend of decreased CW activity, what can we say about the future? Will CW continue to decrease in popularity or what? What do you think? I'll give you my prediction here.

I sincerely feel that the incentive licensing plan now in effect will produce a slight increase in CW activity. The exclusive band segments are a big incentive for a ham to bone up on his code to get his extra class license. As most everyone knows, one of the best ways to get your code speed up is to get back on the air and work some CW. In fact, this is by far the easiest way. Regular and intense practice with code records or W1AW will get you there faster, but it will be more difficult.

The extension of the Novice license term to two years may also cause a slight increase. With more Novices on for longer periods of time, CW activity just may increase. After all, Novices work CW exclusively.

The slight upward trend will probably only be temporary or will show up perhaps just as a less rapid decrease in CW activity. I think that it is safe to predict a continued decrease over the long term. We'll just have to wait and see.

The Case for CW

Frankly I hate to see CW on the down swing. All things considered it's probably the best mode of communications available to us. It is cheaper and simpler to use than any other mode. Using it, you can cover more distance with less power under noisy and crowded conditions than any other mode. And it's the only way to handle normal and emergency traffic. These obvious advantages are continually overlooked because it's so much easier to just talk. It requires less concentration and skill to operate phone. I don't think most hams give CW a chance. Most consider it little more than a nuisance, something they have to learn in order to pass the license exam. Once they have to learn it well enough to pass the exam, it is virtually forgotten until renewal time. If hams would consider CW in a different light, we might see more activity. Don't look at CW as a necessity or a drudge. Look at it as a rare, if not unique, skill that most other people do not have, and be proud of this skill.

Another point is simply that CW becomes easier and more fun the more you use it. It's like anything else unfamiliar. The more we use it, the more comfortable we become with it and the more we will tend to use it. Get in the habit of using CW and I bet that in a short time you will like it. Your code speed will go up, you will be more adept at tuning and copying, and soon it will all become automatic, like driving a car. You won't consciously think about doing it.

I have found that two items really help to increase the pleasure of operating CW. One is a good electronic keyer and the second is a good selective receiver. With an electronic keyer you can send nearly perfect code. This is particularly appealing to a CW man. A good sounding "fist" really stands out. It's a definite mark of accomplishment. In addition, the keyer itself is intriguing. It takes a little skill and practice, of course, to master one, but yet it isn't so difficult as to cause frustration. Most hams, being incurable gadgeteers, find electronic keyers fun to play with and a challenge to use. If you are not now on CW, buy or build yourself an electronic keyer. You'll go nuts until you can get on the air and use it.

Electronic keyers make a good cheap and easy home project if you are inclined to do things yourself. There has been at least a jillion articles on them over the past ten years or so in the ham magazines, so you shouldn't have any trouble locating a suitable design to build from. On the other hand, if you don't like do-it-yourself projects, there are numerous good commercial units available. Get an electronic keyer and enjoy some CW.

The other item that helps to make CW more enjoyable is good receiver selectivity. The key to good CW reception is to have a receiver capable of separating stations operating near the same frequency. Nothing is more annoying than to lose a good contact to QRM even if his signal strength is very high. An adjacent station can easily wipe him out. However, if your receiver is selective enough, you can probably separate the two interfering stations and carry on a decent QSO.

If your station receiver isn't selective enough, you might consider an outboard Q multiplier or tunable audio filter. These are easy to add and do a good job in providing the needed selectivity. Neither requires extensive receiver modifications. If you plan to operate a lot of CW, it will pay to invest in the most selective receiver you can find to begin with.

What's in Store for CW?

Changes over the years have helped to cause a decline in CW interest. As AM, FM, and SSB became popular and more perfected, CW probably suffered some from loss of interest. However, this is not to say that all of the technological changes going on didn't have some effect on the business of CW itself. It most certainly did. The electronic keyer is certainly one development that we can point to. Not only do we have small, exotic, integrated circuit keyers, but also pushbutton, typewriter-like keyers are available. These offer improved convenience in that no CW sending skill is required. Just push the button and out comes the perfectly formed dots and dashes for that letter.

The opposite of a pushbutton keyer is a device that receives the code and automatically converts it into a visual display easily read by an operator. Such devices do exist, but they are complex and expensive. Their big advantage, like their pushbutton keyer counterpart, is that absolutely no CW skill is required. If you know your ABCs, you've got it made. Numerous code receivers like this have been developed for commercial and military use. They are so expensive that they are virtually impractical for ham use. Nevertheless, I guess if they were available, some hams would buy them. Perhaps with modern integrated circuits, an inexpensive unit could be built.

Even though pushbutton keyers and automatic code receivers are entirely possible, I'm not too sure that they are the answer to the CW question. Since no skill is required, there is really no challenge involved. Of course, this is the way it is with phone operation, so maybe such devices could really go over big. If these units could be made available to everyone at a reasonable price, the FCC could do away with the code test and we could all still operate CW without even knowing it. Transmitters would have built-in keyboards while the receivers would contain CRT, Nixie tube or some other form of alphanumeric readout displays.

In the not-too-distant future, perhaps we will see such things in common use. It will be a sort of RTTY, only using electronic means entirely and the standard international code instead of mechanical devices and the Baudot code. It will be sort of like using a computer. We can put the data in and interpret the output even though we don't know how the computer actually works internally. (Is that the definition of an "appliance operator?")

Somehow I just can't see much of this in ham radio. This takes away the pride and the skill of sending and receiving. And I feel that this is still important.

In conclusion, I say we will continue to see a gradual decline in CW activity. The incentive licensing thing may help to hold it up for a while but in the long run we will see less of it. I get the impression that people feel that it is a thing of the past, an inconvenient, cumbersome, and obsolete method of communicating. Perhaps so, but there is still a feeling of tradition and pride that will help it to hang on for years to come. You'll never experience this feeling yourself unless you work CW for a while. Give it a try. Get yourself a keyer and a selective receiver and have a go at it. You might like it. If you really want to be a pioneer, try CW on 6 or 2 meters. There is less QRM up there, more room to move around in, and CW seems to be ideal for these bands. Since propagation essentially restricts the range you can cover, it makes good sense to use CW to help you reach as far as you can. CW will go a lot farther than phone up at these frequencies. See you there. . . . W5TOM ■

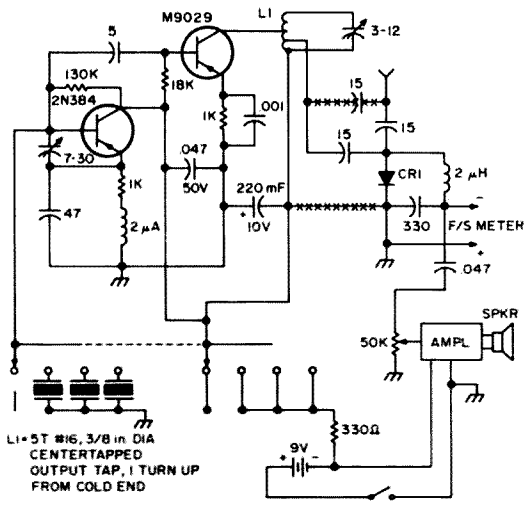
Ed Goldsby W3JKL/DL4UC
Ramstein Air Base
Germany

FM-AM Transmitter-Receiver Aligner

Many articles and ideas have been published in recent months which have been slanted toward the VHF FM'er. Most of them have been directed to the attention of the receiver. Little mention has been made of the transmitter.

I have been using receiver peaking and aligning generators for several years now, and since I am in the FM communications business as a profession, I have often wished that I had a small transistorized instrument that would take care of transmitter frequency and loading adjustments along with the receiver peaking.

The gadget I have conceived cannot be construed to be a precision test instrument; however, it does fulfill most of the requirements of the average VHF FM operator.



Basically, it starts off with the usual peaking generator, (a crystal oscillator and multiplier) followed by a diode mixer/detector and an audio amplifier with enough power to drive a small speaker.

The peaking generator, while generating a small signal for receiver alignment, also provides enough signal to the diode mixer to heterodyne with a signal from the transmitter which, when amplified in the audio section, may be used to align the transmitter to the receiver frequency – or any other preset crystal frequency. Simply tune the transmitter oscillator for zero beat in the speaker.

The circuitry also provides for connection of a relative field strength meter.

In addition to its VHF applications, it works equally well in the HF bands. In my unit, I included a crystal for our local 40 meter MARS net frequency.

I chose to use PNP transistors because I had a 5 pound box of them. In the oscillator, I used a 2N384 and it took off strongly as soon as I applied battery voltage to it.

I tried several unmarked transistors in the multiplier and some of them worked pretty well, but the one I wound up using was a Motorola M9029. Upon checking it out, I found that it is commonly used as an rf amplifier in some VHF receivers. I could find no equivalent 2N number for it.

For the multiplier coil, I used 5 turns of 16 AWG centertapped for the collector and an output tap one turn up from the cold end.

The diode mixer/detector was arrived at by "cut and try" also. I still don't know what the number is because there were no markings on it – not even the usual color bands. However, it works well at VHF frequencies and delivers enough output current to drive my field strength meter to the pin (500 µA) at some distance from the transmitter.

For the audio section, I used one of those little Japanese IW units I got from Allied Radio for $4.95, but I could have used the audio portion of one of those little pocket receivers.

. . . W3JKL/DL4UC ■

5/8 WAVELENGTH VERTICALS

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Wichita KS 67208

Many articles, manuals and even full-length books are devoted to antennas in general and as specifically applicable to the amateur radio service. Unfortunately, one of the most effective simple antennas for both local ground-wave and long-haul DX communications on the higher frequency bands is almost invariably conspicious by its absence. Consequently, few amateurs are familiar with the characteristics, design, or construction of the 5/8-wavelength vertical antenna.

It will be immediately apparent to most amateurs that the 5/8-wavelength vertical antenna will provide an omnidirectional radiation pattern and a vertically polarized signal. And the antenna itself will be 2½ times as tall as the more familiar ¼-wavelength vertical or groundplane. What will not be so obvious, to the uninitiated, is the even lower angle of vertical radiation, the gain obtainable and an additional improvement in reception due to increased capture area over the conventional ¼-wavelength antenna.

These characteristics have made the 5/8-wavelength antenna very popular in the land mobile services and in amateur 2 meter FM operations where omnidirectional vertically polarized ground-wave communications with low-power mobile stations are desired on a full-time basis.

Vertical antennas, almost invariably of the ¼-wavelength variety, have been widely employed in the amateur radio service for DX communications where their low angle of radiation (assuming an adequate ground

system) has proved very effective. Since the polarization of radio signals is generally rotated significantly in the process of reflection, cross-polarization losses are seldom a consideration in sky-wave communications.

Unfortunately, the additional advantages of the 5/8-wavelength antenna have seldom been employed for normal amateur communications. True, a 150 ft vertical for 75 meters or 80 ft for 40 meters is beyond the facilities of most amateurs. However, a 30 ft antenna for 15 meters is well within amateur capability, and 50 ft (20 meters) is within the realm of reason.

Theory of Operation

As a short grounded vertical antenna is increased in length, the radiation lobe narrows, increases in intensity, and the angle of maximum radiation lowers toward the horizon. As the length exceeds ½ wavelength, a secondary lobe of radiation at high vertical angles develops; but the low-angle radiation continues to increase until a height of 5/8 wavelength is reached (Fig. 1). With no equalizing factor, as the

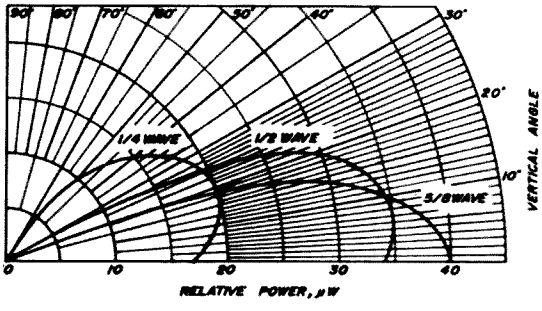


Fig. 1. Low-angle radiation increases as antenna length increases up to 5/8 wavelength.

length is increased beyond 5/8 wavelength, the high-angle radiation increases and the low-angle radiation decreases.

Since the 5/8-wavelength antenna is nonresonant, it presents a highly reactive load impedance unsuitable for direct feeding. At least three basic methods are available to transform this impedance to a 50Ω nonreactive feedpoint.

Probably the simplest method is use of a small series inductance as shown schematically in Fig. 2. The inductance can be

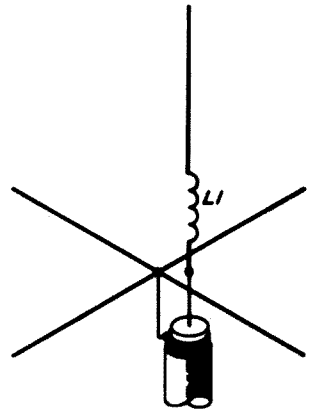


Fig. 2. 5/8-wavelength vertical base-loaded to 3/4 wavelength with series inductance.

considered as base loading the antenna to 3/4 wavelength (with no change in the radiation pattern). This is a resonant length which will present a feedpoint resistance of approximately 50Ω, a very close match to RG-8/U or RG-58/U coaxial cable. Adjustments to the loading coil should provide an swr of less than 1.2:1. In the groundplane configuration, some additional improvement in swr can be obtained by dropping the radials. Approximately 30° below the horizontal will be about optimum with a resulting swr of less than 1.1:1. This configuration has the advantage in simplicity and ease of construction and tuning. It will also be relatively broadbanded when fabricated of materials of adequate strength.

The second feed method utilizes a parallel-resonant circuit tuned to the operational frequency with the feedpoint tapped at a low impedance point on the coil, as shown in Fig.3. This arrangement may be considered as providing high-impedance feed to the base of the radiating element and a direct ground connection to minimize ignition noise and provide a

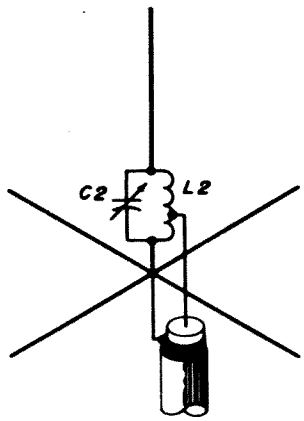


Fig. 3. 5/8-wavelength vertical using parallel-tuned -circuit feed.

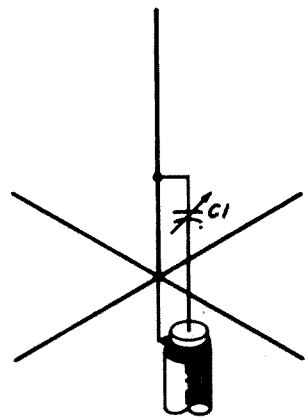


Fig. 4. 5/8-wavelength grounded vertical with gamma match feed.

degree of lightning protection. Coaxial feedpoint tap adjustments in conjunction with minor tuning changes can provide nearly a 1:1 swr at the operating frequency.

The tap point and tuning adjustment interact slightly and initial adjustments are slightly more time-consuming. However, the coil–capacitor combination can be grid-dipped to the approximate frequency on the bench so that only minor touch-up is required.

This configuration has the additional advantages of providing a very low swr without decoupling-radial droop or when mounted on a mobile installation. It will not normally be quite as broadbanded as the first.

A third method of feeding is through the familiar gamma match, as shown in Fig. 4. Here the radiator itself is grounded and the feedline is tapped onto the radiator through a series capacitance. This arrangement also provides a direct ground connection for minimization of ignition noise and a reasonable degree of lightning protection. Feedpoint tap variations combined with series capacitor adjustments can provide nearly a 1.0:1 swr at the operating frequency.

This configuration is particularly adaptable to feeding existing grounded towers as ground system of heavy radials will be required.

Design

The 5/8-wavelength vertical radiator should be reasonably close to a full 5/8 wavelength at the desired frequency but should preferably be no longer. Consequently, the decoupling radials should be a 5/8 wavelength at the high end of the band of operation. Conversely, the decoupling radials should be a minimum of ¼ wavelength at the low end of the operating band. The following formulas are based on reasonable velocity factors for materials probably available in amateur construction and should prove adequate for preliminary design purposes.

$$\text{Radiator length, in.} = \frac{7020}{\text{f in MHz}} \quad \text{or}$$

$$\text{Radiator length, ft} = \frac{585}{\text{f in MHz}}$$

$$\text{Decoupling radial length, in.} = \frac{2880}{\text{f in MHz}} \quad \text{or}$$

$$\text{Decoupling radial length, ft} = \frac{240}{\text{f in MHz}}$$

Using these dimensions, the coupling circuit can then be selected to resonate or provide minimum swr at the desired operating frequency. Though theoretically any coil or coil–capacitor combination which can be resonated at the desired frequency would work, it is important that good tank-circuit design principles and full

weather protection be considered to minimize circuit losses and provide for maximum energy transfer. In general, this implies that all coils be space-wound with large wire or tubing and that length-to-diameter ratios be less than 4:1 (and preferably 2:1). Capacitors should be high quality, ceramic insulated or wide air-spaced variables for ease of circuit adjustment and reasonable power handling capability.

The coaxial feed tap point will vary with different constructional methods and materials and the optimum point must be determined experimentally for each installation. It will invariably be quite close to the ground end of the coil, varying from approximately 1 turn on 2 meters to possibly 3 or 4 turns on 20 meters.

Construction

While this is not intended as a "hardware" style construction article, a few approaches possibly worthy of further consideration have been accumulated.

Conventional TV masting or aluminum tubing is readily available, rugged and inexpensive, although insulation and installation are more difficult than with some other materials.

Of course, the surplus whip antenna segments and their matching insulators are relatively inexpensive, free standing to heights approaching 20 feet; they are relatively light in weight and are available from numerous sources.

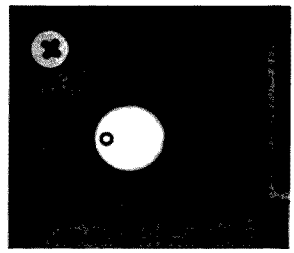
Insulated (or even grounded) antenna towers should make effective radiators for the lower frequency bands, providing an adequate ground radial system is incorporated.

On 2 meters or even 6, a fiber-glass fishing pole covered with shield braid from RG-8/U and RG-58/U makes an ideal radiator. Of course, 1/8 in. welding rod works adequately on 2 meters or higher bands also.

Although this antenna will probably not compete with a good beam or quad at optimum elevations above ground, it is a very effective antenna, readily and economically fabricated with minimum facilities.

. . . WAØNGV ■

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The Intelligent Use of 2 Meters FM

Like canned sardines, today's repeater users are finding themselves cramped for operating time and spectrum.

Peter J. Bertini K1ZJH
257 Elm Street
Windsor Locks CT 06096

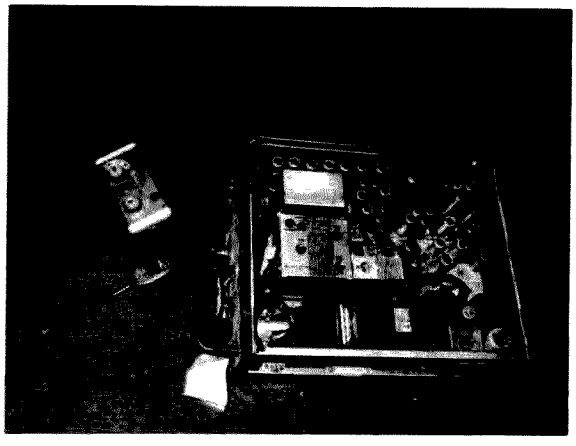
The FM mode may have been shelved with the spark-gap had it not been for an FCC action concerning the commercial FM mobile service. Years back when the commercials were growing by leaps and bounds, it became obvious that the available channels were overcrowded. Since spectrum space was at a premium, narrower FM bandwidths were adopted in order to create more channels. Now the wideband equipment had to be converted over to narrowband at a cost which often exceeded the equipment value, or it was junked in favor of new equipment. Many progressive outfits went the latter route. This increased the "surplus" trickle of FM gear to a torrent. And amateurs, the ingenious scavengers that they are, scooped the units up at bargain prices. Realizing the potential use of this equipment, many hams converted the units for 6 or 2 meters or to the 432 MHz region (FM'ers call it "450"). Clubs and individuals got together and fired the units up on the unused higher band edges and thus a major change was born. These units were fixed frequency and the new concept of "channelized" communication was brought into amateur radio. Unlike the equipment used by the early pioneers, the fixed frequency was new to hams and proved to be an advantage.

After a while across the country standardized channels were adopted by the various groups. As more gear appeared on the market, more amateurs got on FM. Still the growth was only moderate. It was spurred onward by word of mouth and by curious amateurs who found something besides images on the higher two megahertz of their "Gooneybirds."

Hams, using FM for mobile work, followed the commercials' lead and set up repeaters to extend the range of communications. At first these groups numbered between 3 to 20 hams as a rough average. Then FM started to receive the attention it deserved in the various amateur publications. This brings us to the topic of "The Intelligent Use of 2 Meters FM."

Ed Tilton (ARRL, QST official) once said that repeaters "are self-defeating." There can be a lot of truth in these words, but it doesn't have to be so. What would prompt a statement of this sort? Well, during the last few years FM has been growing in drastic proportions. In the last few years magazine articles on FM increased interest and many

repeater groups found their systems filled to overflowing with new traffic. Many systems fell apart or moved to less populated channels. So it seemed the blessing of channelized communication was actually a curse. This unforeseen problem seems to be more of an operator problem rather than a space problem in most cases. One fact is that an



This Motorola trunk-mount rig is characteristic of the two-way units of the '50s. A built-in dynamotor powers the transmitter, while the receiver is driven with a vibrator supply. The control head, shown with mike attached, connects to the unit with a long cable.

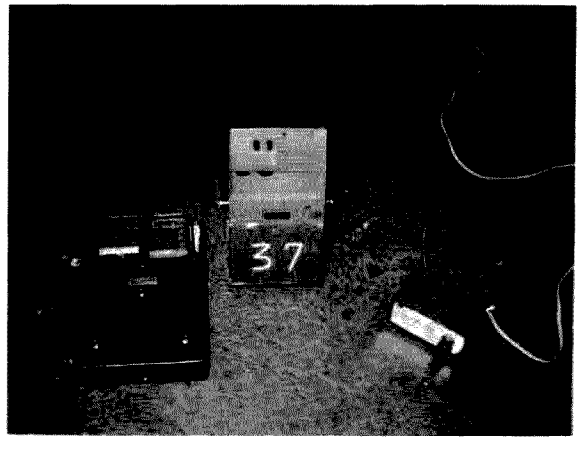
amateur obtaining a surplus FM unit rarely equipped it for anything but the repeater input frequency on his transmitter and the local repeater output frequency on his receiver.

Ideally, a ham using a repeater should be able to transmit on the repeater output frequency as well as the input, allowing "direct" operation without using the repeater. The use of a repeater to ragchew with a lone ham across town is stupid. The use of a repeater located 20 miles outside of town to talk across town is equally stupid, and both instances are examples of a lack of courtesy to fellow system users.

Few FM'ers seem willing to upgrade the receiving portion of their unit. They feel that if they can hear the repeater that is all that there is to it. Period. Case closed. What nonsense! Most units at best are only passable for repeater use and almost useless for extended direct work. One interesting point which has not been made is the "capturing effect" where a strong signal will take over a weak one on an FM receiver. The stronger will usually take over the limiters and the weaker is unheard. Let's use our imagination and explore this point further. Suppose we have four hams on an FM channel using identical equipment. Hams A and B live in Getown; and 10 miles away C and D live in Reaville. Between both towns is a repeater on a slight knoll. Ham A can talk to B, and C can talk to D with no interference to each other because of relative signal strengths. Suppose B and A decide to talk to each over the repeater. Certainly A and B can converse via the repeater, but C and D were blasted off channel by the needless use of the repeater!

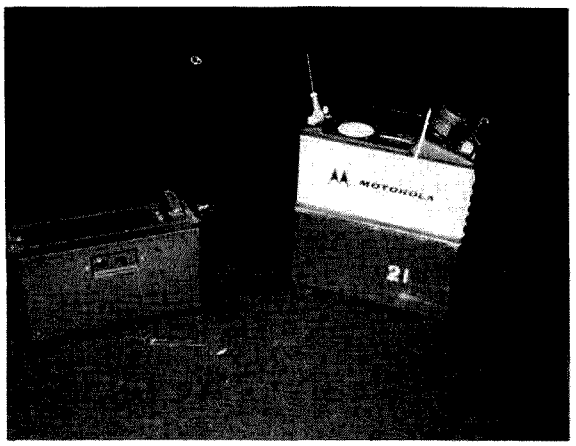
Please don't get me wrong. I have nothing against repeaters. A well thought out and maintained one is not only a joy to use, but a pleasure to listen to. A repeater requires careful attention for the channels used, and the technical problems would fill this magazine. In many areas the standard channels are so crowded that it would be impossible for a new repeater to go into operation without interference to itself or others. It takes only one lid to reduce a system to shambles.

A ham just getting into the FM game finds a new and strange world when he's first



In the early '60s, transistor units made their appearance. The two shown here are GE "Voice Commanders." The unit out of its holster is getting a battery charge from a GE supply built into a control head housing.

introduced to a repeater. All that is needed to be successful is common sense and some knowledge of the operating procedure used. For instance, you should never hear a CQ called. Common practice would be, "This is K1ZJH mobile monitoring '94' direct" or "K1ZJH repeat via W1BNF monitoring 94." This is all that is needed—if any of the group is around you will "break" their squelch with your call; and if they feel like chatting, they'll let you know. Contacts through a repeater are kept short, especially during "busy" hours when everyone is on the road, say on the way to or from work.



Some of the early portable units, such as this Motorola P33, used "hybrid" circuits, with tube-type transmitters and transistor receivers. The lower half of the unit shown is a ni-cad battery pack, and can be replaced with the ac supply shown at left.

A QSO is thrown back and forth like VOX operation, to a lesser degree. Monologues are frowned upon. This allows a breaker to join or the party to bow out if he has arrived at his destination. Many (indeed, most) repeaters have dropout timers that will shut the system off if a continuous signal stays on the input for over a specified period (usually 3 minutes). Generally speaking, there is no time limit for the use of repeater. It is left up to the intelligent use of the user; the system is left in your hopefully responsible hands.

One very irritating thing new system users seem to enjoy doing is keying the repeater on and listening to it "come back." (Some can sit back and do this for hours.) While most outgrow this habit before long, the repeater operators get "up tight" when they hear someone playing games with their system. If you practice such tactics, you will be labeled as a trouble source.

A prospective FM'er will find, while browsing through the lists of available FM units in the ham magazines, a bewildering array of letter prefixed multidigited units listed with no other description present. The best way to find out what would best serve your needs and pocketbook would be to contact an FM'er who has had some experience. While everyone has his own brand of preference, generally Motorola, GE, and RCA gear are best bets since (1) they are still in business, (2) technical data is easier to come by for these units, and (3) there will always be someone around town familiar with their circuitry. Also, there are schematic sourcebooks on the markets for GE and Motorola gear at present.

Once you select and buy your unit, learn how it works and get familiar with working on it. The number of new hams who can fix the guts of the equipment in their car trunk is sadly deficient. This is one item which cannot be crated up and sent back to Heath!

The first rig you will want to acquire will most likely be a mobile unit for the car. A good mobile starts at $75.00 and units converted to the ham band generally run $25.00 to $50.00 more. Try to do the conversion yourself with the aid of an experienced ham. That will help you learn about the unit. Generally, only a retuning is needed, and sometimes some of the coils may have to be padded to bring them into correct range. The mobile unit might well be considered as your major piece of gear. The quarter-wave whip mounted on the trunk lid or roof of the car is widely used. Higher gain coaxials or 5/8-wavelength verticals rate second and are moderately expensive.

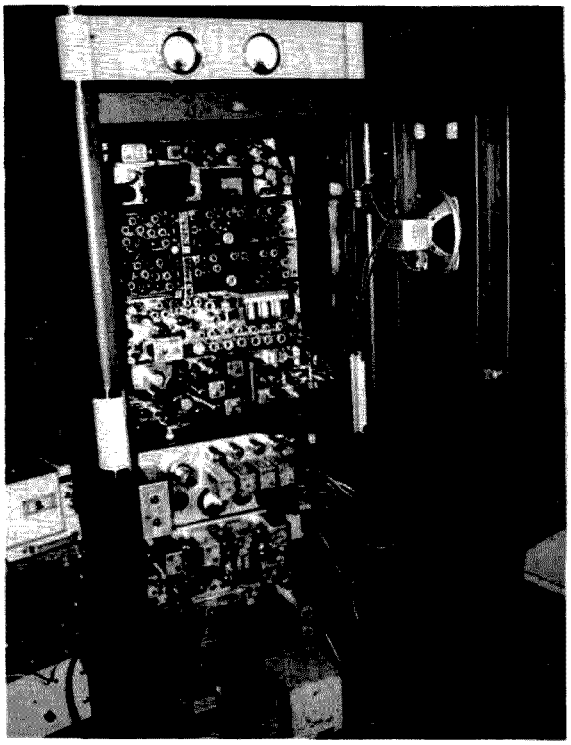
Various stunts can be used to improve the transmitter. Eliminating the dynamotor with a transistor supply and swapping 6146s for 2E26s is a typical modification. Since the average mobile receiver has a sensitivity of 0.7 μV (at a quieting factor of 20 dB), your best investment is a preamp. A Nuvistor job

will bring a 0.7 μV receiver down to 0.5 μV or better in most cases. Reworking the front end will get you down to 0.3 μV or better with a little effort.

If you do a lot of traveling, you may desire to work into the repeater systems in the areas you travel through. The hope for a network of repeaters all on a national input and output is unfortunately impractical. With the number of 2 meter stations currently operating, there would always be someone from system A getting into system B and vice versa. Cooperating between groups has not always been in the ham spirit Paul Segal wrote about, either. The frequencies of 146.34 MHz in and 146.94 MHz out seem to be the most commonly used for repeaters (see Repeater Directory in this issue). On 6 meters, 52.525 MHz is considered to be the main repeater output channel.

W1BNF, the repeater which serves Central Connecticut, recently added a 146.37 to "98" repeater system. The 146.37 MHz channel had to be created because there were no more available channels in the populous New England area! What this boils down to is that you may have to "multi-channel" your unit so that you can take advantage of all of the systems you will want to use or have access to. To do this, some hams stop their cars, go to the trunk, and manually change crystals as they get into different repeater areas. This is acceptable so long as you don't have to do so often or on superhighways. Crystal switching can be done by diode networks, relays (reed relays are ideal), or remote oscillator decks. Commercial units having more than two crystal positions for the receiver or transmitter are rare and expensive.

Most hams, after being on FM a while, eventually desire a base station for home use. Base stations which do get into the ham market command high prices; however, converting a mobile unit for base use is relatively easy since the power supply is the only major modification to be made in such instances. Motorola has provisions for separating its series into three discrete sections: receiver, transmitter, and power supply. A receiver may be removed from a mobile unit and used as a base receiver. Several months later it may be used as a mobile unit by simply inserting it into the mobile case. These "strips" (as they are often called) are



The large base stations usually have sufficient room to contain not only a complete repeater, but the control equipment and UHF gear as well. This rack contains 2 and 6 meter FM equipment as well as power supplies and "link" equipment.

available for quite reasonable sums. Since Motorola (and some others) generally uses the same series of crystal frequencies for their entire line of transmitters, it might be advisable to employ the same make unit in the base as the car. Receiver crystals don't always follow this rule because of different i-f configurations.

In the past few years, a series of hand-held units (dubbed "bricks" because of their size and shape) have been hitting the market. These solid-state wonders are very popular among hams because they were made surplus in commercial service by the advent of even smaller units, containing integrated circuits. The bricks sell in the $300.00 bracket and are made by Motorola. These units make ideal second rigs because of their portability and convenience. But without a repeater,

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their utility would be sharply reduced. At any rate, the brick can be a lot of fun if some of your friends jump on the bandwagon with you.

High-power solid state mobile gear made by all the big manufacturers is now hitting the ham market in small quantities (but usually at prohibitive prices). Watch for price breaks in the next few years on these items. (I was going to get one, but it was worth more than the car.)

As a final note, I should mention the equipment which has come out in the past year for ham use. These units are generally all solid state and sport multifrequency, small size, battery operation, and several other features. The price is around $300.00 for the latest one I have seen. The Galaxy people have marketed a unit for under $200.00 which, besides all of its other extras, offers variable speech clipping!

This article should familiarize the uninitiated with at least the basic rudiments of FM operation. I hope I have helped the beginner avoid some of the common pitfalls which he might have otherwise stumbled into.

. . . K1ZJH ■



WE HAVE A RATHER NOVEL SWR INDICATOR HERE, OM...

Neil Johnson W2OLU
74 Pine Tree Lane
Tappan NY 10983

...plus 10 dB...

A lot of ham operators toss around the decibels quite knowingly, but behind this facade of glib gab, there remains the simple fact that some of the best talkers really don't know what's going on. You can hear it on the air every day, "You're 40 over S9, old man, and this receiver has a very scotch S-meter." In case you don't completely comprehend all this, please don't feel too badly, for there are quite a few young hams – and a few oldtimers – who don't dig this "dB" stuff too well. Years ago, when I was a newcomer to amateur radio, the subject appeared fascinating, and equally incomprehensible.

For simplicity's sake, let us confine our remarks to decibels (dB, to abbreviate correctly) that deal with power ratios. Decibels expressed in voltage ratios may be of interest to phone company personnel, but most ham operators are thinking of their rf output, or lack of it, and that's measurable in watts. We can generalize by stating that the decibel is a nonlinear, or logarithmic, concept. Let's take a specific example. A 100W signal shall be our norm. On this basis we can run up the signal by +10 dB, and we now have a 1000W signal. Okay so far? By the same token if we reduce power to 10W from our 100W norm; we have gone down by 10 dB.

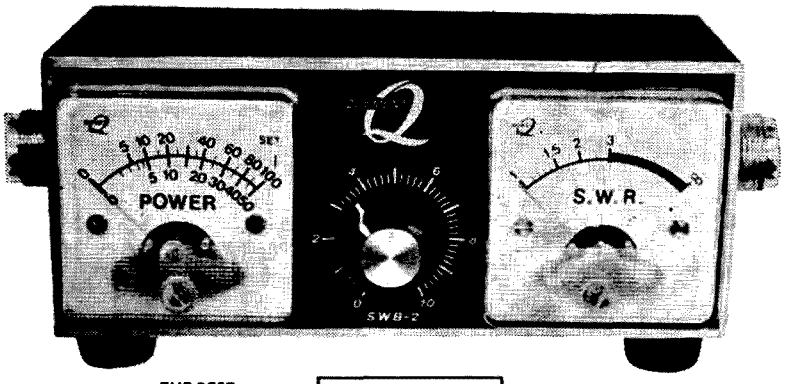
A little bit of history in the matter may set things into better perspective. The bel is a sound power unit, originated by the telephone company people. Clumsy in size, it got cut down to a more reasonable size of 1/10 bel, or *deci*bel. One decibel is the smallest amount of difference in sound power that can be recognized by the trained ear on a wire circuit having normal characteristics. Generally speaking, the rf transmission of power through the air involves fading, atmospherics and interference. Due to this combination of QSB, QRN, and QRM it is generally acknowledged that it takes 3 dB of power change (either up or down) to be noticeable. A 3 dB change in power can be noticed by an experienced operator; this would involve a 2 to 1 change in power, that is either in increase or a decrease.

After reading all this jazz in textbooks, handbooks, and hearing about it over the air, I grabbed hold of a war-weary surplus Variac, and one of the 40 meter ARC-5 "Command" transmitters. I then proceeded to contact a friendly ham about 8–10 miles away. This was strictly groundwave stuff, and to make sure of stable conditions, the QSO was held at 2:30 in the afternoon of an early summer day. The DX was all of 10 miles maximum, as previously mentioned, and most of this was over water. With a little patience, we spotted a clear frequency, and proceeded to run the power level up and down. The ham at the other end was very helpful. You know what happened? He consistently gave me reports which closely agreed with all that stuff in the theory books. All the results were written down in an old logbook, almost twenty years ago.

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With respect to RST reports, just remember that most hams agree that one S-unit involves a power change of roughly 6 decibels. That is, a 100W rig would have to go up to 400W to get a 6 dB change upward. Each time the power doubled, we add 3 dB to our calculations. The first increase from 100 to 200W netted a +3 dB, and doubling again from 200 to 400W added another 3 dB to the signal. Results: power quadrupled, and signal reports up by one S-unit. Sometimes it makes you wonder if antenna work might not pay off better, doesn't it?

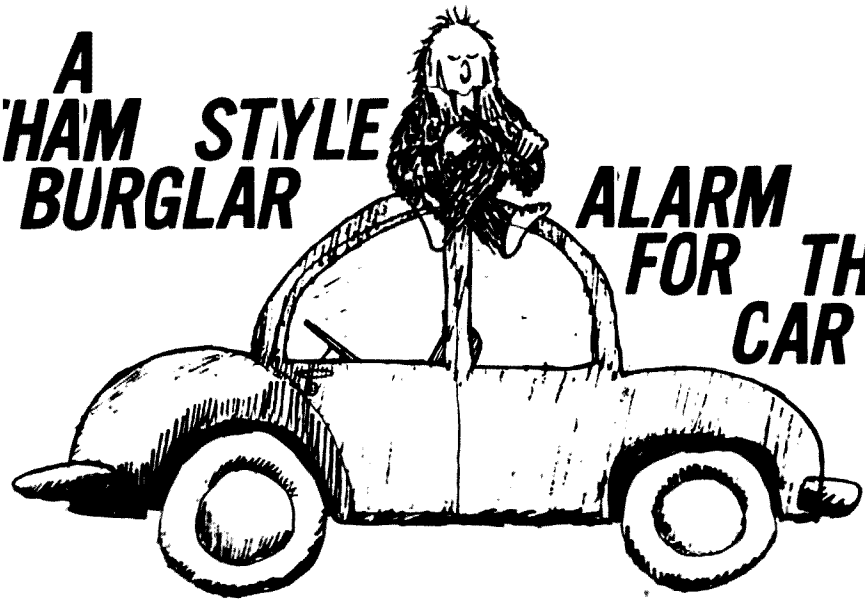
Another way of looking at the whole darned argument is to think about the big money makers in radio, the broadcasters. When a station owner or manager has the opportunity to increase his power, does he go for an increase of 100%? He does not! He wants to be noticeably louder, so that he can sell all those prospective sponsors the idea that he is now "much louder." The way it's generally done is to run the 1 kW broadcast rig up to 5 kW – or the 10 kW outfit goes to 50 kW. These station management people are in it for money – that's the name of the game – and to make a "noticeable improvement" in their signal strength, they usually go up in power by approximately 5 times. This roughly coincides with our illustration above, whereby the 100W ham rig is increased to 400W to get an S7 signal report up to S8.

A quick summary. Doubling (or halving) power gives us a 3 dB change. Making a 4x change – either way – gives us a 6 dB change, or one S-unit. Running a 100W rig up to 1 kW will give a 10 dB gain in power. This amounts to an increase in S-meter reading of about 1.6 units. To put it in a humorous vein, the poor little ham with 100W of power is way behind the commercial station running 10 kW. . .or is he? Look at it this way: There is a difference of 10 dB between 100W and 1000W. Another 10 dB difference between 1000W and 10 kW. That's a 20 dB total difference. But in S-units it only figures out to be about 3.3 S-points on our meter (that is, if you figure 6 dB to each S-meter unit). This may seem startling, but that's the way it is!

. . . W2OLU ■

Chuck Laufman K2JLD
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Bayside NY 11361

A HAM STYLE BURGLAR ALARM FOR THE CAR

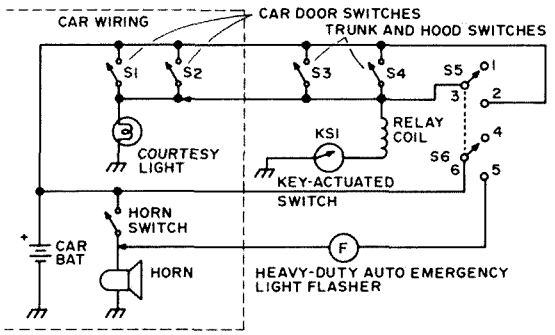


Each month I see announcements about stolen mobile rigs. Until recently the only deterrent to auto burglars which I used, was a warning sticker and a fake key-actuated switch on the side of my car. Several weeks ago I took the mobile rig into the shack for a much needed overhaul, leaving a Heath swr bridge on the floor of the car, where it couldn't be easily seen. The car was parked right in front of my house, and I confidently went about working on the transceiver knowing full well that no self-respecting thief would bother my four-door hardtop for the price of an swr bridge. The fact that my car needed greater protection was brought home to me the next morning when I discovered that my bridge was gone. The crook had wedged a coathanger between the front and rear door windows and used it to pry up the door-locking button. I installed the alarm described in this article, and it has proved very satisfactory to date. It can be duplicated for about $5 (and even less if you have a well stocked junkbox). The alarm will cause your car horn to beep on and off if a door or the hood or trunk compartments are opened, and the horn will continue beeping until you reset the alarm.

The sensing devices used are the car's own door light switches. The contacts of these switches are easy to reach and provide a convenient place to tap power for the alarm. These switches can turn on your alarm and still be used in their intended manner. If your car's rear doors are not equipped with these button switches, you may add them by drilling the appropriate sized holes, and mounting them by the rear doors in the same way as the front switches. At the same time you should mount one in the hood compartment and one in the trunk and wire these in parallel with the others. They should, of course, be positioned so that they are controlled by opening and closing these compartments. These switches cost about 50 or 60 cents at your favorite auto supply shop. You will have to unscrew some of your car's interior molding or trim, and feed the wires under the carpeting of the car. When you are done, opening any of the doors, the trunk, or the hood should cause the interior lights to go on.

The master control on/off switch is usually a key operated one, and may be purchased from Lafayette radio for a few dollars. It should be mounted convenient to the driver's door, and it is best to locate it so that is is covered on the inside by some sort of trim, so that one cannot just open the door and rip out the wiring. I was lazy and installed mine in the trunk com-

partment, but this is not a good practice. If you are super cheap you can use a single-pole toggle switch and mount it inside the door to the gas filler cap, where it won't be seen. Some people have suggested that a spark from the switch could ignite gas fumes, but 99% of the time there is no current going through the switch when it is being thrown. (*But stand by for that last*



S1, S2 *Car door switches*
S3, S4 *Additional switches for trunk and hood*
S5, S6 *Relay contacts.*
KS, *Key-actuated switch*
F *Heavy-duty auto emergency light flasher*

hundredth. – Ed.) A popular spot for the key-actuated switch is behind the headlights on the front fender.

And now, about the circuit. As you can see from the diagram, the door light switches will supply 12V to the interior lights when the car door is opened. They can also provide 12V to turn on the dpdt relay. Contact with these switches is best made by removing one of the switches from its mounting and tapping into the wires connected to it, using wire nuts. When the relay is actuated by these switches, one set of its contacts closes and is connected so as to provide continuous voltage to the relay coil even after the door switch is turned off. Only turning off the main switch will release the relay. The other set of contacts on the relay goes in parallel with the horn switch. The wires from this switch can be traced from the steering column. When the relay is activated the horn will go on. The heavy-duty emergency flasher is used to make the horn blast on and off, a distinctive sound which will tell you that you are hearing your car, and not just another irate motorist.

Any type of 6 or 12V dpdt relay will serve this purpose, providing the contacts aren't too small. I used one which was mounted on an octal base, and mounted the whole assembly on an L bracket under the dashboard. There is nothing critical about the construction. Details of feeding the wires through the car and opening your car's interior moulding will vary with the particular car.

There are several drawbacks to this particular system, the main one being that if your car is tampered with and you aren't around, chances are good that you'll wind up with a dead battery. But, into each life a little drain must fall. It's very easy, of course, for the thief to open your hood and disconnect the two horns when he hears them go off. With a little ingenuity you can make this inconvenient for him. Or, buy a used horn from your local junkyard and mount it in or under your trunk, and wire it in parallel with the others. Your unwanted friend will go crazy trying to find it, and this will also make a good warning signal for those nasty people who are always standing in back of your car when you have to back up. Some bad guys like to get under your car and cut your battery cable before the alarm goes off. You can cover your battery cables with shielding from BX cable. It is flexible and can only be cut with a hacksaw. Only the very hippest auto burglars carry hacksaws.

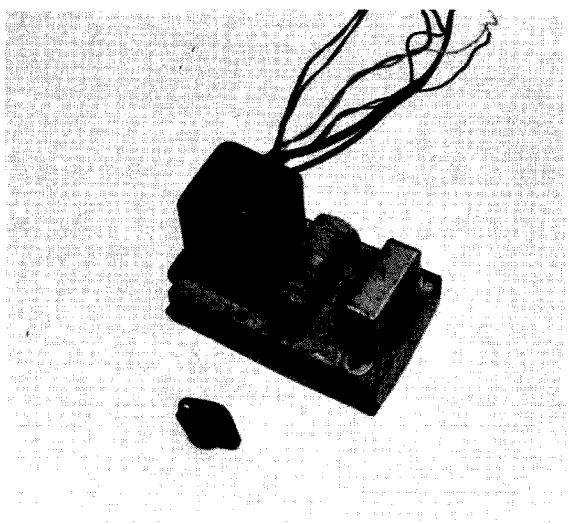
There are many other variations and sophistications for this alarm system, including a tape-recorded message which tells the guy what you think of him. With a little effort all the headlights can be made to go on and off. To complete the job, a few warning stickers can be added to your windows and the door-lock buttons can be changed to smooth cylindrical types which can't be pried up from the outside. There is practically no limit to what you can do. But remember, no matter what you design, there is a thief somewhere who, if he really wants to, can still get around any alarm system.

. . . K2JLD ■

POWER SUPPLIES from SURPLUS COMPONENTS

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National City, CA 92050

This article originally began as a brief description of a small power supply intended to deliver 22½ volts at a few milliamperes for a transistorized preamplifier. However, because of the wide variations of the components available and the desires of builders, it was decided to extend this article into as complete a description as



possible of power supplies in general. The main objective, of course, is to allow the builder to design his own power supply to fit his own needs. However, it is strongly felt that most readers will want to know what they are doing, even if they can do it quite well. It is for this purpose that all attempts have been made to include explanations or derivations wherever it is possible, especially where a concept is so logical and uncomplicated that it is easier to simply know why or how it works rather than to memorize meaningless formulas or circuits. So, actually this project had a much earlier beginning, with the destruction of about ten dollars' worth of silicon diodes. Its final success was achieved after a college course in electronics engineering, and the most useful information is described in this article.

The Transformer

If the builder has an adequate power transformer for the desired project, he might skip this section. However, the desired voltages at the desired prices are not always available, and if the power requirements are

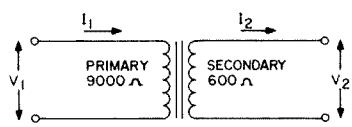


Fig. 1. Schematic of a typical audio transformer and its parameters.

small, an interesting substitution can be made.

Several audio output transformers were obtained from surplus, but they all had a 600 ohm output impedance, and were unfit for driving a speaker. At the same time a six transistor audio preamplifier was hungrily earing up 22½ volt batteries. It soon became apparent that the cost of replacing batteries could easily exceed the cost of the preamp. Store-bought power transformers are also costly, compared to the low priced epoxy

transistors. It was finally decided to try an experiment.

A schematic of a typical transformer and its parameters is shown in Fig. 1. By assuming the transformer to be 100% efficient, we write the equation for the power in the primary and secondary.

$$P_1 = P_2 = I_1^2 Z_2. \qquad (1)$$

The subscript 1 indicates primary, and the 2 indicates a secondary parameter. Equation one says that the power in the primary equals the power in the secondary, which is

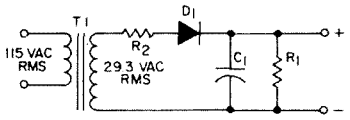


Fig. 2. Half-wave rectifier circuit.

equal to the current squared multiplied by the impedance. If we now use algebra, and divide equation one by Z_1 and I_2^2, equation two will result.

$$\frac{I_1^2}{I_2^2} = \frac{Z_2}{Z_1} \qquad (2)$$

Now the impedance ratio is expressed in terms of the currents. Since we know that current is voltage divided by impedance, a substitution can be made for I_1 and I_2.

$$\frac{I_1^2}{I_2^2} = \frac{\frac{V_1^2}{Z_1^2}}{\frac{V_2^2}{Z_2^2}} = \frac{Z_2}{Z_1} \qquad (3)$$

By manipulation of equation three (dividing it out), equation four is obtained.

$$\frac{V_1^2 Z_2^2}{Z_1^2 V_2^2} = \frac{Z_2}{Z_1} \qquad (4)$$

If equation four is now divided by Z_2^2, and then multiplied by Z_2^2, the final result is obtained.

$$\frac{V_1^2}{V_2^2} = \frac{Z_1}{Z_2} \qquad (5)$$

Now that equation five is established, it is possible to find the voltage ratio in terms of the impedance ratio.

This derivation was given to show how equation five could be obtained if it were forgotten or was unavailable. This is assuming Ohm's law is known and a knowledge of basic algebra is available.

Equation five can be made more useful by dividing both sides by V_1^2, and inverting the result.

$$V_2^2 = \frac{Z_2 V_1^2}{Z_1} \qquad (6)$$

To obtain V_2, we take the square root of both sides of equation six.

$$V_2 = \sqrt{\frac{V_1^2 Z_2}{Z_1}} \qquad (7)$$

Equation seven is the final result, and the output voltage of our transformer can now be found.

V_1 is 115 volts, the line voltage, and Z_2 and Z_1 are 600 and 9,000 ohms, respectively. Plugging these values into the formula we get:

$$V_2 = \sqrt{\frac{(115)^2 (600)}{9{,}000}} = 29.3 \text{ volts} \qquad (8)$$

Thus, if 115 volts is put into the primary, 29.3 volts will come out the other end, and it can be rectified and dropped down to 22½ volts.

Designing the Rectifier

There are two primary factors that work together to destroy silicon diodes; excessive voltage and excessive current. An example of each of the most common circuits will be discussed, and the ratings required for the diodes will be determined.

The simplest rectifier is the half-wave circuit shown in Fig. 2. Assuming that the reader is familiar with this circuit, we shall proceed to find the *peak inverse voltage,* or PIV required for the diode. Since the RMS, or effective voltage, is given for the transformer, the peak voltage must be found. The reader must remember that this is a sine-wave voltage where the voltage varies from zero to some positive peak value, goes back to zero, goes to a negative peak value, and finally back to zero sixty times each second. A complete mathematical proof would require the use of calculus which is beyond the scope of this article, but a reference is given.[1]

The peak voltage at the secondary of the transformer is the effective voltage multiplied by the square root of two.

$$\sqrt{2} \times V_2 = 1.414 \times 29.3 = 41.4 \text{ volts peak.} \qquad (9)$$

Let's assume that R_1 in Fig. 2 has so high a resistance that C_1 charges up completely to the peak voltage, 41.4 volts, and does not discharge. Also, we shall assume that the top of the transformer secondary winding has reached its peak negative value of -41.4 volts. By adding the voltages, we can obtain the equivalent circuit of Fig. 3,

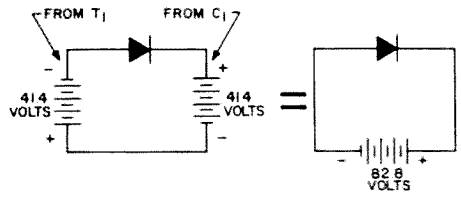


Fig. 3. PIV equivalent circuit.

with 82.8 volts across the diode in the reverse direction. Recall that conventional current is from + to - in the circuit connected to the voltage source. Since current flows in the diode in the direction of the arrow, if current were flowing in the diode, it would be in the reverse, or inverse direction. This indicates a peak inverse voltage of 82.8 volts in this case. To survive, the diode would have to have a PIV of 82.8 or more volts. We always design equipment with a safety factor to prevent unexpected changes. If a safety factor of 50% were used, 50% or 82.8, or 41.4 would be added to 82.8, giving 124.2 or more volts as the desired voltage requirement.

The current rating that is most often given for a silicon diode is for the current that it will be passing under normal continuous operation. A safety factor should also be included here, but there are much higher currents that are present only for a short period of time. Suppose now, that the circuit of Fig. 2 has been turned off for a long period of time. C_1 will be completely discharged by R_1. Assume that the circuit is turned on at the instant in the ac cycle so that a positive peak voltage suddenly appears at the top of the secondary winding of T_1. Since we know that the voltage across a capacitor cannot change instantaneously, the capacitor will appear as a short circuit for an instant. In effect, R_2 and D_1 will be in series across 41.4 volts for a very short period of time. If R_2 is a small resistance, a high current will be forced through the diode. This is the reason a resistor is usually seen in series with diodes in a power supply. Since the internal resistance of the diode is usually very small, it is assumed to be zero, and a resistor is inserted in series to take up the surge. The resistance is determined by Ohm's law, with knowledge of the peak secondary voltage of T_1, and the allowable surge current. R_2 is usually somewhere between 20 and 40 ohms, so by picking a value, say 30 ohms, we can find the allowable surge current. By plugging values into the following formula we get:

$$I = \frac{V}{R} = \frac{41.4}{30} = 1.38 \text{ amperes surge.} \quad (10)$$

Now, this is a relatively low surge current because diodes with a few hundred milliamperes of continuous forward current rating can have a surge current of ten to twenty amperes or more.

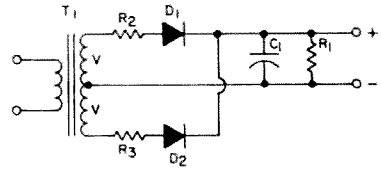


Fig. 4. Full-wave center-tapped rectifier.

Figure 4 shows the full-wave rectifier. Of course, this circuit can only be used with a center tapped secondary, so it would be useless with the transformer that was available. It gives a smoother output waveform that is easier to filter, and a short discussion of the PIV should be included.

Figure 4 is a familiar circuit, and just a glance will show that it is actually two half-wave rectifiers fed 180° out of phase by the transformer. The output is connected in parallel across C_1 and R_1. As in Fig. 2, the peak inverse voltage is twice the peak value of each half of the secondary plus a safety factor. The reader should go through Fig. 4 as we did with Fig. 2 to satisfy himself that the result for the PIV is correct. Also, the surge current can be determined in a similar manner as was done for the circuit of Fig. 2.

Now, we turn to the circuit of Fig. 5, which is the circuit most likely to be used for the application we desire. In order to

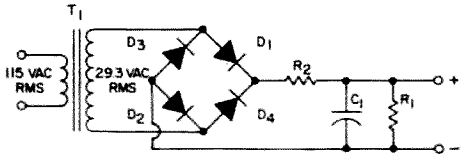


Fig. 5. Full-wave bridge rectifier.

study this circuit it will have to be divided into two parts, one for the positive, and one for the negative half-cycle of the ac voltage.

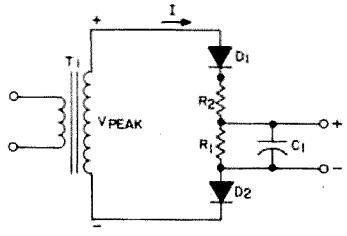


Fig. 6. Positive half cycle of the full-wave bridge rectifier.

Fig. 6 shows the half-cycle in which the top of the secondary of T_1 is positive. Note that the diodes that do not conduct are omitted from Fig. 6 because they act as open circuits. We now have a much clearer simplified circuit that will show how the full wave bridge works. R_2 is the surge limiting resistor and will have a value of:

$$\frac{V_{peak}}{I_{surge}} = R_2 \text{ (surge resistance)}. \quad (11)$$

V_{peak} is the peak voltage at the secondary of T_1, and since the diodes act as direct shorts, a current, I, will flow through the diodes, R_2, and R_1, and C_1. Also note that C_1 is considered to be a short circuit for the surge calculations as was done before. I_{surge} is the allowable surge current that passes through the diodes if the circuit is turned on at a voltage peak. The reader has probably noticed that since the diodes offer a short circuit during the half-cycle that is being described, a dc voltage will be generated across R1 and CI that will become the output voltage, V_{dc}. Now, take a look at Fig. 7, the negative half-cycle simplified circuit. If the reader traces the path that the current travels through D_3, D_4, R_1, and R_2, it is easy to see that this is the correct equivalent circuit. In fact, Fig. 7 is just Fig. 6 turned upside down when the transformer polarity changes and the diodes act as a double-pole double-throw switch to keep the

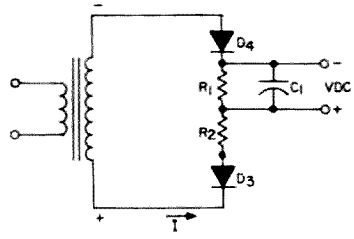


Fig. 7. Negative half cycle of the full-wave bridge rectifier.

current flowing through the load (R_1 and C_1) in the same direction in both half-cycles.

To find the PIV for each diode, assume that the secondary of T_1 in Fig. 7 is at its peak voltage in the opposite polarity. Also assume that C_1 is charged to the peak voltage of T_1, and there is no voltage drop in the diodes or R_2. The voltage drop will be small because the current is small. Now, showing only the diodes and the voltages, we have the equivalent circuit of Fig. 8. This shows how the voltages add to make up the maximum peak voltages across the diodes in the reverse direction. Since there are two diodes, the voltage divides equally between them[2], and the voltage across them is V_{peak}. This is one-half of the voltage of the diodes in Fig. 4, so lower PIV diodes may be used, but twice as many are needed.

If the same transformer is used, the peak voltage (from equation nine) is 41.4 volts plus a 50% safety factor. The PIV would have to be at least 41.4 + 20.7=62.1 volts peak.

If diodes are to be placed in series to obtain a higher overall PIV rating, something must be done to equalize the voltage drop across each diode. All diodes are different, and one will pull more current than another, resulting in one diode having a large voltage across it which causes it to break down and short out, throwing all the voltage across the other diode, or diodes, and eventually the whole string of diodes is destroyed. This was a common happening when the builder was unaware of the real meaning of PIV. Since they short out rather than burn open, the

transformer can be burned out if it is not fused.

To prevent this, voltage dividers can be placed across the diodes to provide equalization. Since the diode is operating in its reverse direction, (very, very small current flow) the internal resistance of each diode is very high, and resistors between 100K ohms and 500K ohms can be used across the diodes to provide equalization. 220K ohms is a typical value. Capacitors across the diodes can also be used, but can be more expensive. One should be careful to calculate the required power or voltage rating for the type of equalization system to be used. It should be noted here that it is often less expensive to use higher PIV diodes and fewer resistors, particularly when inexpensive surplus diodes are used.[3] Determine the cost per PIV ratio for each kind of diode, and be sure to include the cost of equalizing resistors when making the choice.

Filters

The value of filter capacitors and chokes, and the size of the load will in general determine the output voltage and ripple content. This is, of course, depending upon the type of circuit and transformer used. It is possible to calculate these values, but a number of factors are listed that would preclude a detailed discussion of this.

1. Very precise results are usually not necessary in amateur work.
2. Any parts that are available will probably be used if they look as if they will work, regardless of their values.
3. The actual value of a commercially made electrolytic capacitor may vary by as much as 60% from its marked value (check the label).
4. No serious damage will result from experimentation so long as the voltage ratings are adequate.
5. It's easier to put it together and try it than figure it out, in most applications, and more reliable (no math errors).

Also, it should be noted that charts and graphs are available which can give a rough idea of what the ripple content from a certain type of rectifier will be.[4]

Final Comments

The circuit of Fig. 5 was used in the power supply shown in the picture. The filter system used a capacitor input system with capacitances of 40 μF and a choke of unknown value. The diodes were 1N92s with a PIV of 200 volts and a 25 ampere surge rating. The continuous current rating was 100 mF, so all ratings were adequate. It works very well.

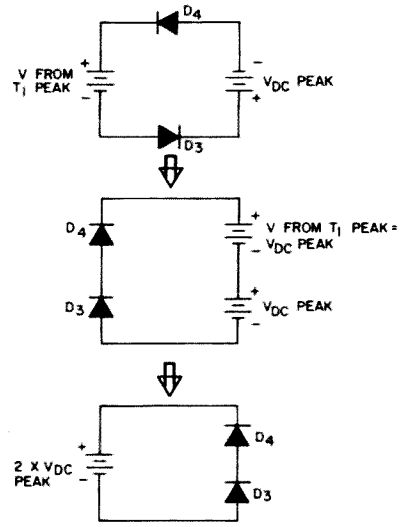


Fig. 8. PIV equivalent circuits.

The main objective of this discussion has been to provide information that can be used to safely construct any type of power supply from whatever components are available, and little emphasis was placed on any particular circuit or design. It was decided to use this approach to allow the reader to design his own power supply rather than having to dig through countless articles to find one that will give him what he wants that he can build with the components that he has on hand. Also, the reader appreciates the satisfaction to not only design his own equipment, but to actually know how and why it behaves as it does.

. . . WB6BIH ■

References:

1. Fitzgerald, Higginbotham, and Grabel, *Basic Electrical Engineering*, McGraw-Hill. See page 138 to prove equation nine.
2. If resistors are placed across each diode. Go back and keep reading.
3. Such as Solid State Sales or Poly Paks. See the ads in the back of this issue after going back to read the rest of the article.
4. *ARRL*, The Radio Amateur's Handbook, Newington, Ct. See page 307 for filters.

Selectivity has come a long way.

Today we take for granted shape factors and ultimate rejection figures that were considered either impossible or extremely expensive twenty years ago. Practically all single sideband equipment has a pretty good filter network in the I. F. system to establish the selectivity pattern. It may be a high frequency crystal lattice network, or the lower frequency mechanical type.

There are three factors about the I. F. filter that determine how well it will do its job. The one most commonly recognized is the width of the passband, usually measured at a point 6 db down from minimum attenuation.

This bandwidth is what determines the audio frequency range you can transmit and receive through the filter. The wider the passband, the wider the range of A.F. It becomes necessary, of course, to choose a happy compromise between a narrow bandwidth to help reduce QRM, and a wide bandwidth which will provide more natural sounding voice quality. You'll find that the Swan filter has a 2.7 kc bandwidth. This gets us into another subject which we'll discuss another time.

Shape factor is the next consideration in measuring a filter's quality. This is the ratio between bandwidth at 60 db and 6 db down, and is a measure of how steep the attenuation curve is outside the passband. This factor is often referred to as "skirt selectivity." The narrower the passband at 60 db down, the better the filter will attenuate strong adjacent channel signals. A good crystal lattice filter will have a shape factor of 1.7 to 2.0 depending on its center frequency. Best shape factors are achieved right around 5 mc, which is one of the important reasons for Swan's I. F. system being at 5.5 mc. On the other hand, the lower frequency mechanical filters don't have quite as good a shape factor as high frequency crystal filters, a fact which isn't very well known, and may come as a surprise to many.

Ultimate rejection is the third, but certainly not the least important measure of how good the filter is. All filters eventually "flare-out" at the base of their attenuation curve. This tells you how much the filter will attenuate signals which are 10 or more kilocycles outside the passband. If you have a base attenuation level which is down 80 db, for example, a strong local signal may very well come through the receiver over quite a large portion of the band, and it won't be his fault! There's no point in telling him how broad he is if it's your filter that's falling down on the job. A good high frequency crystal filter having 6 or 8 poles will reach ultimate rejection levels of 100 db, or more. Here again, filters in the 5 mc region are better. So, all you happy Swan owners may as well know the facts and blow your horn a little. CF Networks has made that beautiful precision filter that's installed in your rig, and it's really a dandy.

The accompanying graph illustrates clearly what we've been talking about. But so far we've only been discussing the "standard" Swan filter, and comparing it with other typical 9 mc crystal filters and 455 kc mechanical filters. In case you hadn't noticed, there's a tall, skinny curve on the graph that's all alone. This is the new SS-16! Made exclusively for Swan by CF Networks, this 16 pole quartz filter network establishes a new standard of comparison. Shape factor of 1.28, ultimate rejection greater than 140 db! A giant QRM killer, the SS-16 wipes out strong adjacent channel interference with unprecedented attenuation. And in transmit mode, unwanted sideband and carrier suppression are both increased greatly. For a new experience in Super Selectivity, install the SS-16 in your Swan Transceiver. They are available for the current 5.5 mc, I. F., or the earlier 5.175 mc I. F. system. Installation and adjustment is quite simple, and our famous customer service department is, of course, available for assistance if required.

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RF RIVIERA STYLE

Being an electrical engineer and a ham, I have for many years maintained the one-eyed "Gooneybox," Gonset 6 meter Communicator in my cars, changing every year or so to a newer model car and with the change, moving all the ham gear into the new car.

For years, I had no trouble changing the rig from one car to the next until last December when I leased a 1969 "loaded" Buick Riviera. This car is truly a beautiful "mechanism" and I could hardly wait till I could transfer the "Halo," install the Communicator, and start transmitting. The Communicator fitted well over the hump of the transmission – and, after attaching the coax, I started up the engine and turned on the rig. I was greeted with a noise level like nothing I had heard before. I might as well sit beside the battleship Wisconsin while she fires a broadside. I was unable to hear a thing! I was getting hash which sounded like it was about 80–100 Hz. There must be something wrong with my rig, I deduced! After all the years it has been in use, it probably has blown its cool. I turned off the engine and the noise level went away. Nothing serious. Something probably was not grounded properly.

For the next five days I bonded, sealed, and tightened every possible joint and connection. But the noise was still there when I turned the engine on.

Several months passed and it was in the spring that I finally wrote the Buick people explaining my problem. It took 1½ months for them to come up with an answer which I had already tried. I had reached an impasse!

Again, I surveyed the entire car and tested for various "leaks," searching with a "sniffer." Sure, I could pin down the area of the noise; but now, while the engine was running I had, one-by-one, disconnected just about everything – yet the noise persisted.

More months went by and by this time I was getting old and feeble and my "Riv" still had not stopped "generating" a noise. Then, sitting down in the car one day, I started the rusty brain clicking. Why was my car different? What did my car have that made it so different? What was it that pulsed or vibrated even when the alternator, voltage regulator, and everything that could be disconnected *had* been dis-

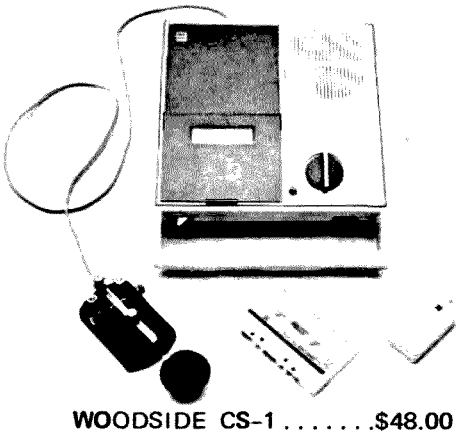
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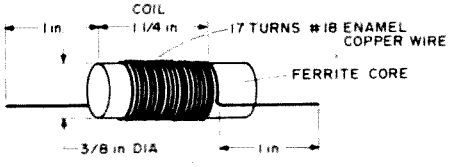
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connected? The answer came on me like a flash flood.

Buick had done us Riviera owners a big favor: to justify increased costs, they gave us all a big fat juicy electric fuel pump. Now all I had to do is find that stupid pump – the one remaining electrical apparatus I hadn't checked out. In years gone by, the purchaser of a car would receive a book that would tell the grease points, wear points, ignition points, etc.; so, easing my hand into the glove compartment (it is so small you have to *slide* your hand in), I grabbed my instruction book with the tips of my fingers and slowly pulled the book out so as not to tear off the top skin of my hand. I scanned the book. No index, and no mention of a fuel pump, either electrical or vacuum.

I called all my engineer friends over to the house for beer and help, and we all started to slowly circle the car, each trying to come up with a solution. Where was that furshlugginer pump? Here we were, six engineers – and no one could even suggest where we might find the fuel pump. Finally, someone suggested it might be under the trunk floor – only as a desperation move, we looked. And sure enough, there it was. . . a black Bakelite cap with a blue and a brown wire coming from it and heading in the general direction of the front of the car.

Back down into the shack we went to make up a low-impedance coil, but here we had one problem. By this time, the brew had us slightly staggering and no one could read the grid dip meters. But after a couple of hours we did manage to make up a coil. After it was installed, I started the engine and turned the Gooneybox on . . . Voila! It worked, and I immediately made a contact with a ham about 30 miles away. No more hash!

But where are the 6 meter hams? The band is dead here now!

. . . K9BDJ ■

KEEP 'EM COOL IN "KPO CANS"

Douglas Byrne G3KPO
Jersey House
Eye, Peterborough, England

Tubes get too hot for comfort, burn themselves up aplenty . . . what to do? Keep 'em cool, boy, keep 'em cool!

Easier said than done, for while tubes get smaller, nobody has yet succeeded in miniaturizing the watt. Of course, you can use a blower, but that brings with it problems of vibration and noise, both mechanical and electrical.

So let's see if we can't get that unwanted heat away much more efficiently by the normal method of radiation and convection—with the aid of flappy tailfins! No noise, nothing to wear out, and best of all—no cost . . . here's how.

Heat is extracted from the tube by a special heat-dissipating shield made up of a series of individual tin plates shaped as shown in **Fig. 1**. End D has direct thermal contact with the tube body, extracting heat by conduction, transferring it to end E, where the heat is removed by radiation and convection of the circulating air.

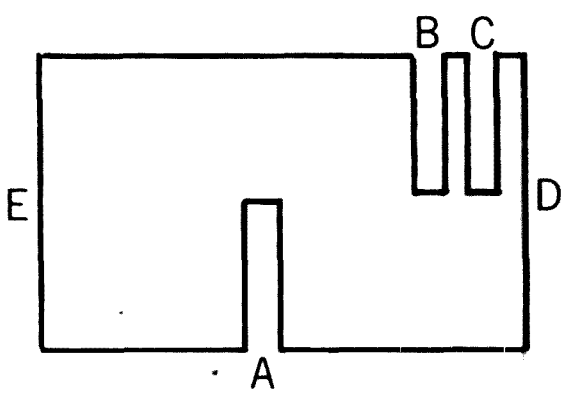


Fig. 1. An individual plate.

To make, you need to cut a half-dozen or so small sheets of fairly flexible sheet metal (2½ x 4 in. will be about the right size for the usual PA tube).

Snip a slot in each plate as at A in Fig. 1, and a few more as at B and C—cut each slot sufficiently wide and deep for A of one plate to slide easily in B or C of the next, the bottom and tops being level with each other.

To assemble the thing, slide slot A of one plate into slot B or C of another. Continue until you have a circle of plates, with an opening in the center for the tube and the flappy tailfins sticking out all around.

Paint all fins flat black. Black has a heat-absorption characteristic and will enhance the overall efficiency of your dissipator.

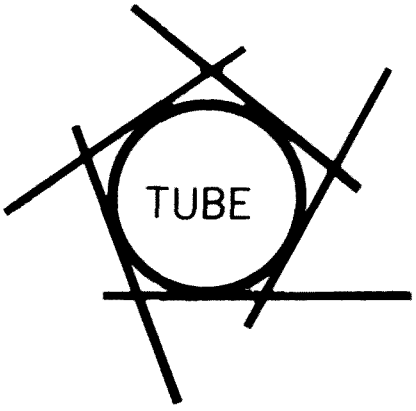


Fig. 2. Plan view of complete shield on tube.

Now try it on for size. If slightly out, select slots B of C as appropriate. If much too large, cut a new slot. Slide over tube and bend or cut tailfins to avoid nearby components.

A secondary benefit of the shield is that it will reduce direct radiation of heat onto such things as vfo coils and electrolytic capacitors, where it is definitely NOT wanted.

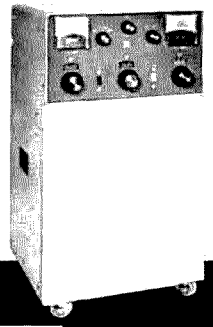
A good point to remember is that not all circuits will be able to tolerate the tube capacitance introduced by the shield. Some experimentation is warranted in most cases. Retuning will be required in virtually every case.

... G3KPO ■

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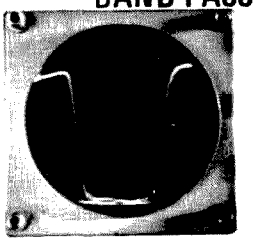
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This second part of a two-article series on a reasonable cost, portable "ideal" i-f for the amateur homebrewer describes the design method and working breadboard model of the 1.65 MHz to 135 kHz converter module, a 135 kHz i-f filter which really cuts the mustard, an avc module for use with the Motorola HEP 590 IC i-f amplifier, and the results when using the whole i-f system. If you like plenty of lows when listening on the bands, this is the unit for you; the bandwidth is between 3 and 4 kHz, which is cutting it pretty close for good voice quality. Of course, when the going gets real tough, you don't care about quality, but you do care plenty about understanding what your contact says. That's when a narrow bandwidth really helps.

The possibilities for the homebrewer with this double-frequency i-f seem quite interesting; indeed, I'm anxious to get one packaged for myself, along with a tunable packaged 10 meter front end for use with VHF and UHF converters.

Overall System

Figure 1 shows the block diagram of the complete triple-conversion portable receiver. Previous articles have described detailed construction of various portions of this system. This section is concerned with the 1.65 MHz to 135 kHz converter, the avc module, and the 135 kHz filter.

On the subject of mixers, be sure to read the "trouble" section, where it shows what happens when you put a high Q coil in the collector circuit of a lively mixer and leave the emitter only partly tied to ground. In this condition, you're in grave danger of very strong oscillation on 1.65 MHz (if that is the frequency of the output circuit).

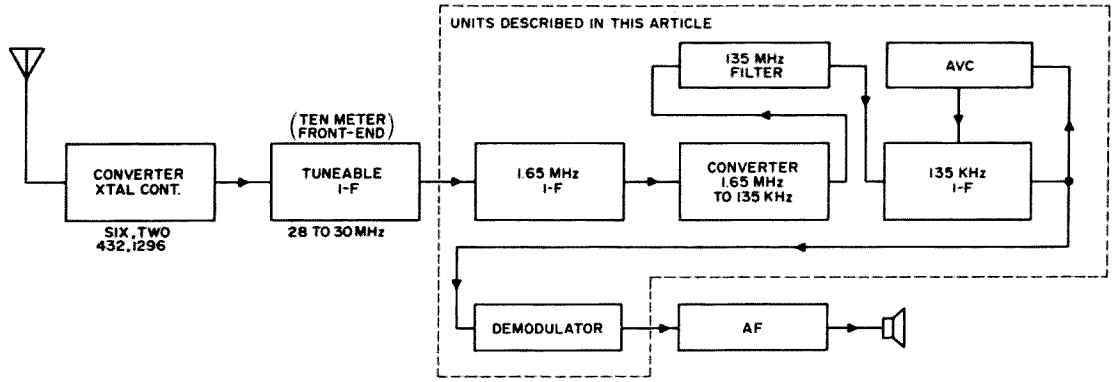


Fig. 1. Block diagram, ideal i-f system.

Instead of the first crystal-controlled converter followed by the tunable 10 meter front end, you can use a tunable 6 meter job if you wish, resulting in a double-conversion receiver. You can even use it that way on 2m, but tuning gets pretty touchy then. The crystal oscillator in the VHF–UHF converters relegates the tuning business further down the line to the 28 MHz region, where it can be done in a reasonable fashion.

Once the i-f system is packaged and installed in a little carrying rack along with the desired converter and companion solid-state transmitter, it should make an extremely interesting and useful addition to portable amateur equipment –and at reasonable cost for the homebrewer.

Mixer

In the past I have described several 1.65 MHz mixers, but this is the first using ready-made coils that you can buy on the market; that is, these are the Miller series, described in detail in the first part of this article. Of course, you do have to add an extra winding or so, but the coil form, adjustable center threaded core, tuned winding, outer powdered-iron core, and the aluminum case are all there.

Various types of oscillator injections were tried, and the one shown in Fig. 2 is the result. It uses straight link coupling from the oscillator inductor to the mixer base coil, and has the nice feature that the amount of coupling is easily adjusted for the best

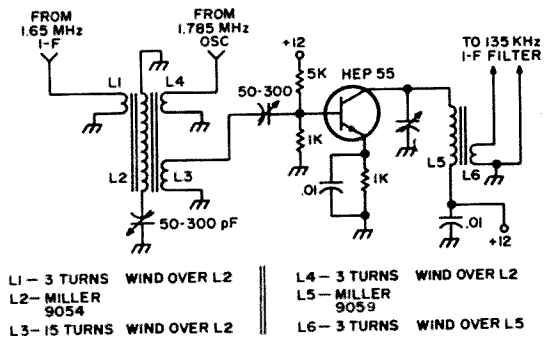


Fig. 2. 1.65 MHz to 135 kHz converter mixer detail.

effect. This is useful because if you undercouple you lose gain, and if you overcouple you can get frequency "pulling"; unwanted

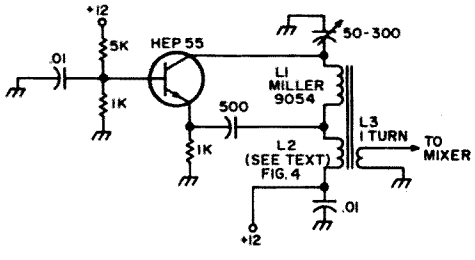
harmonic power rises also. You will notice several windings of only 3 turns or so, which is a small number at an intermediate frequency. This is possible because of the powdered-iron cup core used, which increases the magnetic coupling and the Q of the coils. Figure 2 shows the mixer circuit using the Miller coils.

Here's how it works: Signal energy from the 1.65 MHz i-f module comes in on L1 and is transferred selectively to L2, and from there to L3, which is matched to the base input of Q1. Oscillator energy at 1.785 MHz is supplied also to Q1 via L4, and the two signals are mixed, or beat, in Q1, to furnish a collector output on 135 kHz.

The collector circuit is tuned to 135 kHz with a Miller 9054 inductor and a mica compression trimmer of 100 to 500 pF. A link of 3 turns is wound on top of the 9054 winding to couple energy to the filter. The base and the emitter are treated in the usual fashion for dc bias, with the emitter heavily bypassed to ground, which effectively eliminates self-oscillation.

1.785 MHz Oscillator

The basic circuit of this oscillator has not been changed from that described in the first article, but this time it uses coils that are readily available. The Miller 9054 unit works fine with the addition of only 6 turns of wire to create an emitter feedback tap, as in Fig. 3, and a pickup link to transfer the needed energy over to the mixer.



L1 = Miller, 9054
L2 = Add-on winding, see text and Fig. 4.
L3 = 1 turn.

Fig. 3. Converter, local oscillator, 1.785 MHz.

How to do it. Remove the aluminum can from the Miller 9054 coil by bending back the little tabs holding it in place, and make sure that the outer cup core stays in place inside the can. Figure 4 shows the oscillator winding details. You *must* get the direction

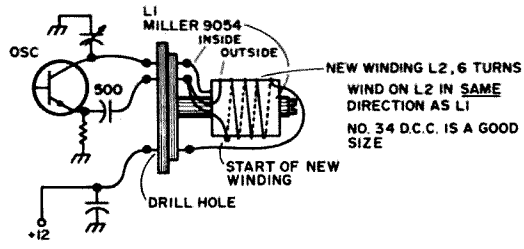


Fig. 4. Oscillator coil detail, 1.785 MHz.

of the feedback winding right or it will not oscillate. Find the direction of the winding making up the original 9054 by looking for the wire coming off the outside and going to one of the two terminals. Then wind on an additional 6 turns in the same direction without changing L1. Figure 4 should show you exactly how this is done. Join the start of L2 to the outer end of L1 at the pin. This point will now become the emitter tap connection as shown in Fig. 3. Bring out the finish of L2 and connect it to the B+, bypassed by C3.

Wind on one turn for L3 on top of L1 and L2 (a little coil dope helps hold them on). I use coil wax for easy changing, due to my experimental work, but coil dope cement is all right once the circuit is working correctly.

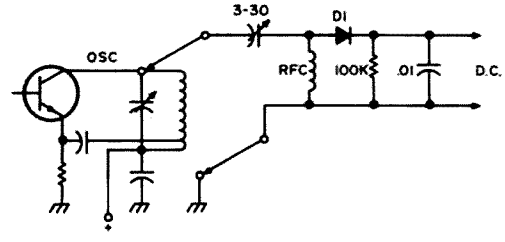


Fig. 5. Diode rf tester.

And that's it. You can clip on an rf detector as shown in Fig. 5 for a check on power and frequency. Use an absorption wavemeter or a dipper in the diode position for this test to find the fundamental. Then you can trim up to an exact spot with your receiver.

Use the least amount of power needed to drive the mixer. This will cut down on 1.785 MHz harmonics and "birdies" from getting into the front end of your complete receiver. The value of shielding cannot be overemphasized. Keep any and all rf out of the battery leads, and keep closed-in cable connections to your beam antenna lead.

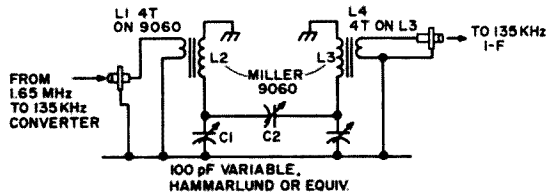
The best things for elimination of birdies can thus be listed as follows:

- Reduce oscillator power.
- Carefully shield the oscillator and mixer, and filter the battery leads.
- Shield the front end from nearby pickup.

Note that the birdies are 1.785 MHz harmonics and are not i-f leakage, which is pickup of signals on 1.65 MHz. I-f leakage is much more troublesome up front in a receiver, such as on 10 meters, between the 28 MHz tuner and the VHF or UHF converter. In times past I've been startled to hear a W9 calling CQ on 2m, only to find he was on 29 MHz. Plenty of VHF converter output swamps such pickup, and good cabling and front-end shielding help to minimize that type of leakage.

Do-It-Yourself-Filter

As mentioned in the diode section (later) on demodulation, the more tests I make, the more I like the diode across the entire inductance; however, the selectivity suffers a little as a result. Looking for that sometimes-elusive 3-4 kHz bandwidth, I decided to check the operation of a filter. I'm not always particularly impressed with the way some designers use filters. They have a tendency to use just one filter and a lot of amplification along with it, and it doesn't always sound right in operation. So this one was started with plenty of reservations; but after several days of trial and retrial it turned out to be a real goodie. That is, when used in *conjunction with* three other other tuned circuits as well as on 135 kHz. Figure 6 shows the circuit which is a simple "top-coupled" two section job. There are several methods of coupling filter sections, such as link, mutual induction, and magnetic (wound on the same core but spaced). The one shown worked out best and is fairly easy to adjust, with one caution: With a given number of link-coupling turns, maximum transfer of energy may be 10 dB or so down, even with the best adjustment of C. It is a



L1 = 4 turns wound on 9060
L2 = Miller 9060
L3 = Miller 9060
L4 = 4 turns wound on L3

Fig. 6. 135 kHz filter.

combination of the proper number of link-coupling turns (L1 and L4) that produce the happy result of low transfer loss and minimum usable bandwidth.

Theoretical design of filters is a very complicated affair mathematically, with no place in this article. Just make it as shown in Fig. 6 and it will do fine. The entire i-f is already too sharp for a hi-fi AM tuner right now, and does cut the highs noticeably. You could add another filter with possibly another HEP 590 in between but then you might not be able to use it on AM voice.

This filter, in combination with the three other tuned circuits, has been put to use here for several days, changing back and forth between 10 meters, the BC band, and the signal generator. This BC band can be quite informative when used with the signal generator and the amateur bands, because you do want to be able to understand the other party to a QSO even though you're looking for a lot of selectivity. When you have 8 to 10 kHz of flat-top bandwidth, you can do pretty well on the clear channel stations. This clear channel business concerns the FCC's frequency allocations and does not take into account the ideas of Canadians, Mexicans, and Cuban broadcasters, to mention a few. The best thing to do for this test is to check your location and the frequency allocations for a strong local and a not-too-distant next-channel station in the daytime. Incidentally, look out for those BC stations that use *over* 100% modulation. The most powerful one in Massachusetts does just that!

When I check on the signal generator, using the filter, and measure ±1.5-2 kHz for about 6 dB down, I've got a good communications set bandwidth. This shows up on the BC band with definite cutting of highs. Bear in mind we are not talking about a $600 set, which can afford bandwidth switching. This is just a good homebrew filter job that can be put together on your bench for a few dollars, plus more than just a few days.

For best results this unit should be installed in a Minibox, although it also handled well on a copper-clad 5 x 8 in. baseboard. You can also switch the filter in and out, with suitable care, as in Fig. 7.

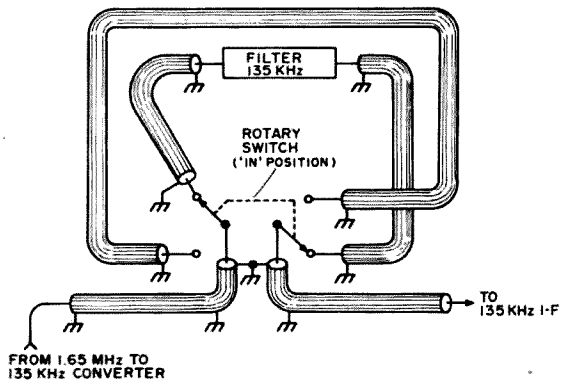


Fig. 7. Bandwidth switch, 135 kHz filter.

Demodulator

I spent lots of time on the demodulator, most of it in conjunction with the bandwidth determination and the filter operation, as these all go together to produce the desired results. The avc system is also tailored to fit in with the demodulator.

Believe it or not, those of you new readers who have yet to experience hours-long DX work on VHF or UHF, the "rushing" sound of the noise made by the receiver itself can be important. It should not be a shrill hiss; it should be a "businesslike" roar, of low tone, and the slightest hint of a signal, even the smallest fraction of a microvolt, should be detectable (by ear as well as on the S-meter). You can see the logic of this when you consider the bandwidth of noise itself. With this i-f system, demodulator, filter, and af, the above is what happens. Of course, you *do* need a low noise front end also and this need automatically becomes greater as you go from 6 to 2 meters, and on up.

Figure 8 shows the best circuit found for the important function of demodulation. With this one you *will* hear that signal, the af

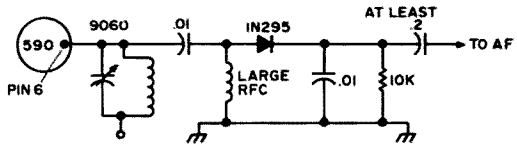


Fig. 8. Best demodulator circuit.

quality will be good, and your chances of enjoying those QSOs will be best.

It should be followed by a good tone control circuit and a good af amplifier such as the Amperex TAA-300, and a good speaker. You need some lows in there to punch through the QRN.

AVC Circuit

The use of the Motorola HEP 590 as an i-f amplifier results in considerable advantage, but it also changes the avc requirements, as you will see.

Referring to Fig. 9, pin 5 of the HEP 590

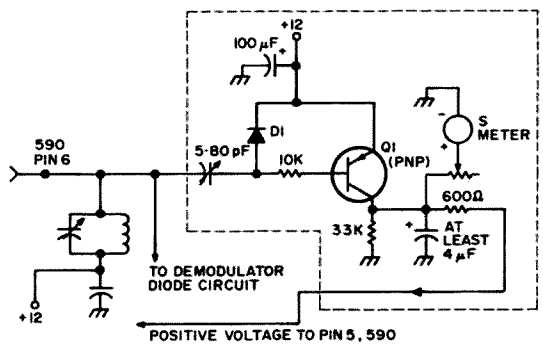
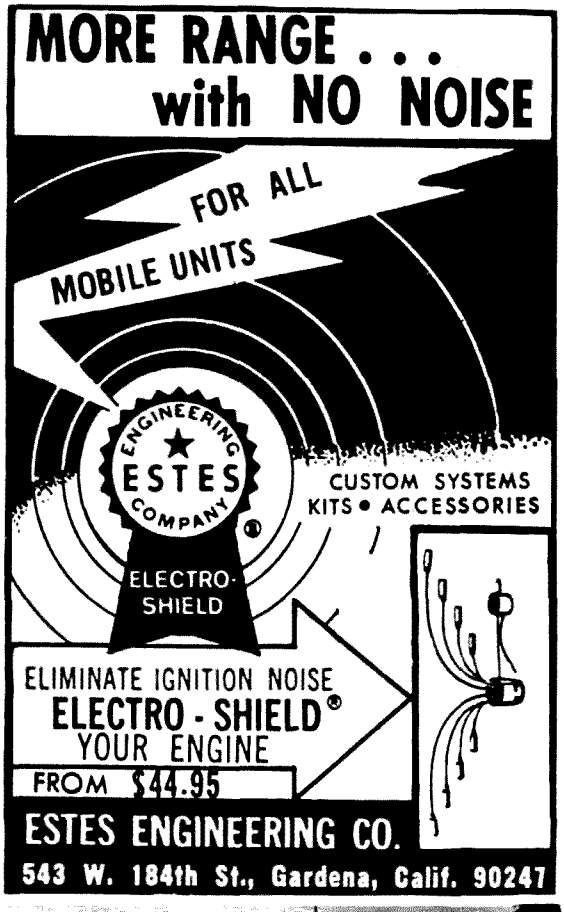


Fig. 9. AVC module.

is the avc connection. When pin 5 has 6V or more of positive voltage, the current of Q1 is shunted through Q3, and taken away from Q2 which reduces the gain of the entire circuit. The big advantage with the IC is that avc can be applied to the last i-f stage, which is also the same stage that is driving the avc system. With a single transistor amplifier stage, this is not normally recommended, but with the HEP 590 it works fine. Another advantage is that you now have places to install an S-meter that reads forward. This is





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across the avc amplifier collector resistor (Fig. 9).

Figure 9 shows the final circuit which holds the rectified dc voltage down to less than 1V—even on those Texas kilowatts. A *PNP* transistor is used in an "upside-down" fashion as the avc amplifier. An advantage of the use of an avc amplifier is that very little of the i-f energy is needed to operate the avc system, and no noise at all is contributed by it to the signals.

When testing this out on a signal, with the avc module removed from the IC, the effect of connecting or disconnecting C1 from the i-f was hardly noticeable. I may be a fanatic on conserving demodulator power and quality, but it sure pays off when listening to those DX UHF stations!

When testing this out on a signal, with the avc module removed from the IC, the effect of connecting or disconnecting C1 from the i-f was hardly noticeable. I may be a fanatic on conserving demodulator power and quality but it sure pays off when listening to those DX UHF stations!

How it works. Referring to Fig. 9, a small portion of the 135 kHz i-f energy is taken off the IC output inductor through the trimmer C1 and fed to diode D1. Capacitor C1 is a very handy place to adjust the amount of avc action. With a meter checking the dc output of the demodulator, backing off on C1 drops the avc output and raises the diode voltage to a point where D2 overloads. Increasing C1 raises the avc output and drops the voltage on D2 to less than 1V on the loudest signals. You can set this to suit your own fancy.

The i-f voltage on D1 causes negative voltage to appear at the base of Q1 (a PNP connected upside-down), which then conducts, driving the collector towards the +12V. This positive output is filtered by C3 and applied to pin 5 of the IC amplifier where, as soon as the 6V level is reached, it begins to cut down on the gain of the HEP 590. On a very strong signal, like a W5 on 10m with an ordinary band opening, this voltage may reach plus 7½V or so. It is perfectly possible to apply the avc voltage to the HEP 590 used in the 1.65 MHz i-f also, but this is taken up later, when the whole

system gets packaged into its 99% "ideal" form, in Miniboxes.

Don't be worried about the upside-down PNP. This is a usual practice nowadays. Just "stand" on the +12V bus as though it were the ground, along with the emitter, and look at the ground as though it were the battery voltage for the collector. It works!

Complete System Tuneup and Operation

This is where you can really take it on the chin as you first turn the entire rig on, with unbelievable sounds coming from the speaker. Too much gain, birdies, low-frequency burble, high-frequency oscillations, broad-tuning squeals, and assorted tunable hisses are some of the things that can assault your ears when you connect an antenna, the 10 meter front end, the first i-f, the second converter, the filter, the second i-f, demodulator, af, and speaker—and switch on the battery. (The overall circuit, incidentally, is shown in Fig. 10.)

Table I. Coils for "ideal" i-f system.

L	Number of turns or coil type	Notes
1	1 turn	Wind on 9054
2	Miller 9054	
3	4 turns	Wind on 9054, L2
4	9054	
5	3 turns	Wind on 9054, L4
6	3 turns	Wind on L7
7	9054	
8	3 turns	Wind on L7
9	15 turns	Wind on L7
10	Miller 9059	
11	3 turns	Wind on L10
12	9054	
13	6 turns	Add on to L12 (text)
14	1 turn	
15	4 turns	Wind on L16
16	Miller 9060	
17	Miller 9060	
18	4 turns	Wind on L17
19	5 turns	Wind on L20
20	9060	
21	10 turns	Wind on L20
22	9060	
RFC	Large	Self-resonant below 100 kHz

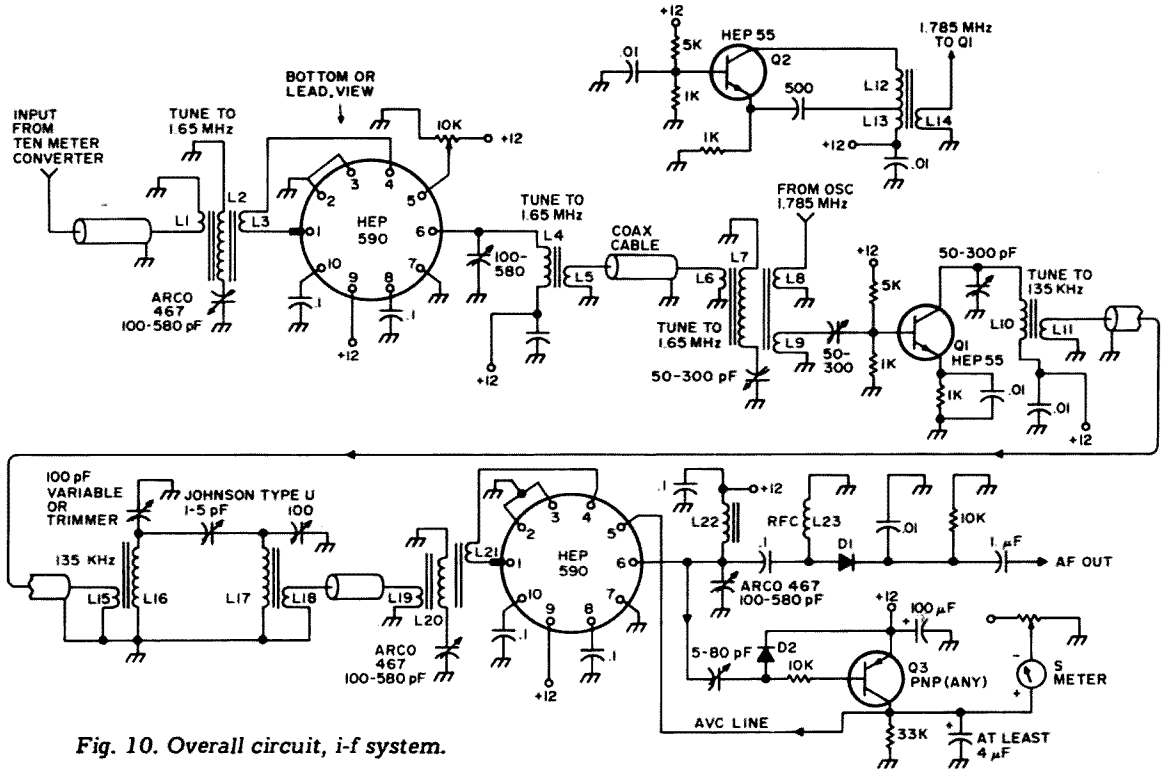


Fig. 10. Overall circuit, i-f system.

In commercial receivers you often see items such as a 300Ω resistor in series with the mixer collector, going to the i-f output transformer, or a large bypass capacitor to ground on a mixer emitter which at the same time is supposed to receive oscillator injection. It does apparently, but only in spite of all known electrical laws! Such fixes can be considered legitimate in that they do allow the system to operate in a satisfactory manner, but in my work I feel that the readers deserve to be told the truth—if it can

be found! It is not always easy to dig down to the basic troubles, though—especially in cases like birdies in the front end from a second local oscillator (or third, when triple conversion is used). It also takes space because when your breadboards are spread out over two benches (see block diagram, Fig. 1) your i-f, af, and speaker wires can sometimes radiate just enough spurious to get back into the antenna wires or front end, with high gain and loud signals—that is, if shielding, closed connectors, and coax cables are not used. A beam, or at the very least a coax-connected antenna outside the shack, is very useful.

Mixers in particular are always suspect for my money. I have recently changed from my favorite mixer circuit over to one in which the mixer emitter is firmly tied down to the ground plane, rf-wise. This whole system performed in fine shape as soon as the mixers received the above-outlined treatment and avc was applied. The work on the demodulation proved especially valuable, allowing plenty of good i-f voltage to be handled by the diode. This in turn makes for good avc action, which has been detailed in the avc section.

You can also see that packaging of each unit, removal of rf and i-f from the battery wires, and proper interconnections can be quite important. The use of a shielded cable going to at least a two-element beam outside the shack is recommended.

You *do* want a powerful, selective, portable receiver, don't you? One that can be used on 6 or 2 meters or the UHF bands? And in a nice little carrying rack with a companion transmitter? With quite a lot more work to come in the packaging bit, we hope to finally provide you with the plans for such an "ideal" rig, of reasonable size and cost, for use anywhere.

Trouble Department

You might think a mixer would be the last item in a receiver to develop real trouble. After all, it is supposed to just sit there, and is not supposed to oscillate or amplify, although some of them do have quite a lot of conversion gain. What would you say about one that oscillated about 5V worth all by itself?. . .cut off the local-oscillator drive, remove any input and still it oscillates? Well, it happened here and it could happen to you. So here I tell it like it is and I hope it will help you to avoid at least that trouble. It cost me days and a burned out HEP 590 too.

Figure 11 shows the circuit that did it. DO NOT USE IT! It so happens that to make an oscillator, you ground the base, put a tuned circuit in the collector, and lift the

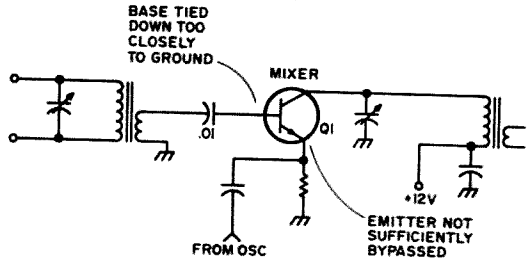


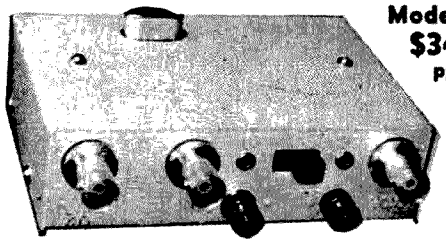
Fig. 11. Trouble-prone mixer circuit. (Do not use.)

emitter off *ground*. See the resemblance? In that mixer the emitter can be considered to be grounded through C2, but it is *not* a *positive* ground. Also, the base is not supposed to be grounded, but there is a very short low-impedance path through C1 and L1, or the base input tap on the rf collector coil. Well, to cut the sad story short, it *did* oscillate. . .like mad! So the circuit shown in the mixer section, Fig. 2, was installed and so far *this* mixer has not oscillated since then. Period.

Results

The finished system was hooked up as shown in the block diagram, Fig. 1, with my faithful old 100 ft wire attached to the 10 meter front end. Being early in the morning, the first station on the dial was a ZS in South Africa, pushing the S-meter around in lively fashion, soon followed by lots of others over there. A little later W5s came booming in to provide checks on the avc section with extra-loud signals. Some of these latter produced nearly 10V of demodulator diode output with the avc off. This overloads it, of course, and it is not used in this condition. With the avc connected it held nicely to 1V or lower, adjustable by the 5-8 pF avc coupling capacitor. Manual control is applied to pin 5 of the 1.65 MHz IC amplifier, as indicated in

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the first part of this article, to regulate the overall sensitivity and the amount of receiver noise. The results of using an excellent demodulator, the Amperex TAA-300 "baby hi-fi" amplifier, and a good speaker now showed up in a pleasing fashion. Advancing the af gain as for use in mobile work or in a large noisy room, etc. did *not* result in tinny audio or distortion, but produced good quality audio which was a pleasure to the ears.

The avc swallowed up 90% of the QSB, even 100% of everything that could reasonably be called Q5. As mentioned in the avc section, the small trimmer coupling capacitor bringing i-f energy over to the avc module provides excellent adjustable regulation of the amount of avc you may prefer.

The use of a good dial in the tunable i-f on 10 meters is imperative for an i-f of this bandwidth. The Miller MD-4 two-speed dial does a good job in that unit.

If you want to "steal a march" on my work here, install a bandwidth switch in front of the filter to cut it in or out. Figure 7 shows this unit, but mind you, I haven't installed it yet, so you're on your own. I have plugged and unplugged the filter though, many times, so I know what will happen if you beat me to it. There is an increase in bandwidth when you cut the filter out. This is good for non-DX contacts and locals. For real DX, switch to the 3–4 kHz bandwidth position, which cuts it down to the minimum noise condition.

Conclusion

Design methods, breadboard circuits, overall tests, and results have been detailed for you, trending well on the way towards an "ideal" battery-operated i-f system with low image and high selectivity, which, when packaged, will be a very useful piece of equipment for the active VHF–UHF amateur.

This will soon be matched up with the packaged, single-dial, three-gang tuned 10 meter i-f for use with any VHF–UHF converter, homebrew or store-bought. You will then have an excellent, portable, solid-state receiver that cannot be bought ready-made on the market today.

...KICLL ■

epoxies for electronics

Elliot S. Kanter W9KXJ
3242 W. Hollywood Ave.
Chicago IL 60645

With the wealth of new materials and devices available to the ham today, it seems a shame to keep on building with worn out and antiquated methods. I am speaking of soldering, a process that has changed little since the days of heating a soldering iron over an open flame and then melting wire solder. This progressed to electrically heated irons or guns, but the basic principle remained the same: heat the solder and the terminal.

Until recently this was about all we could use and we tried to make the best of it. Heatsinks had to be used to protect our semiconductors, and of course, we had to be sure we didn't overheat the PC board and lift a conductor.

Well, there *is* a way to get around the problems of cold solder joints and heat-damaged components: *epoxy*! Not the usual form of epoxy, mind you, but an altogether different form—one which is electrically conductive, that can be cured at room temperature. I dashed off a line to Emerson & Cuming in Canton, Mass., and received a wealth of information on the world of epoxies. I learned that there are epoxies which are thermally conductive, yet still electrical insulators, and that a product called Eccobond Solder 72C was the IC manufacturer's answer to the solder of yesterday.

I sent away for some of this "solder" and followed the simple mixing instructions. A test circuit was put together using the liquid solder as a conductor between a battery and a small lamp. It worked like a copper wire, and during the cure period could be moved or removed with ease. Ohmmeter checks showed that it has low resistance and remains stable regardless of the applied voltage.

Next, I tried to solder dissimilar metals together (a copper wire to an aluminum chassis) and found it would not only provide a solid electrical bond, but had good mechanical properties as well. A friend borrowed some and proceeded to wire his new transceiver using the epoxy solder in place of regular solder. His report: no cold solder joints, no heatsinks needed, and—best of all—no heat-damaged components.

The epoxy solder in one form or another has found acceptance with many manufacturers of electronic equipment since it allows good reliable connections by unskilled personnel and in many cases does away with heatsinks.

Looking further into the catalog and spec sheets, I discovered thermally conductive epoxies which allow you to use the chassis as a heatsink. All you have to do is squirt a glob on the chassis and press the transistor into it. The epoxy presents a thermally conductive bond which is still an electrically isolated one.

All of the various forms of epoxies are available from the major electronics distributors and may be found in their industrial catalog section. Say goodbye to burned fingers and soldering irons and move up to conductive epoxies. The component packaging specialists did it a long time ago.

. . . W9KXJ ■

FET Preamplifiers FOR VHF FM

Earnest A. Franke WA4WDK/2
108 Matawan Terrace
Matawan NJ 07747

A grounded-gate FET preamplifier for 6 or 2 meters offers high gain, simplicity of construction and ease of tuning.

Many amateurs come to the point where they need an extra preamplifier for wider coverage with their mobile FM operation. I have constructed several field effect transistor amplifiers for 6 and 2 meters which yielded many interesting results. Approximately twice as much gain may be achieved when using a field effect transistor in the grounded-source arrangement as compared with the grounded-gate configuration for the same bandwidth; however, neutralization is almost always required. By using a field effect transistor in the grounded-gate configuration, the amplifier was simple to build, gave adequate gain and bandwidth with a low noise figure and ease of tuning. The low feedthrough capacitance eliminated any need for neutralization. The only tuning after construction is to peak the two tank circuits for resonance. When the preamp is used in mobile operation, the supply voltage may be taken from the car battery.

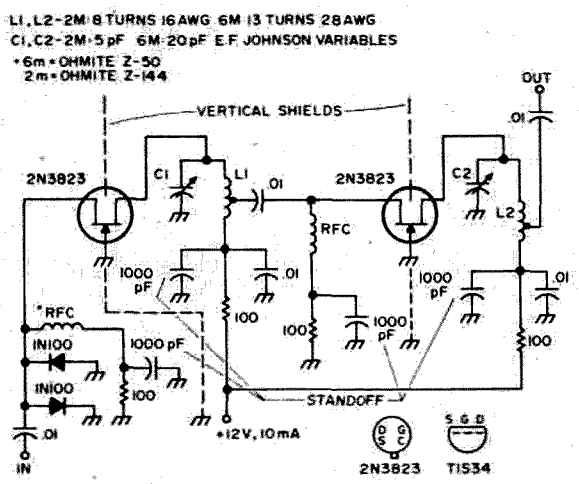


Fig. 1. Cascade preamp circuit, using two grounded-gate FETs, provides plenty of rf gain on 6 or 2 meters. Frequency-sensitive values are listed at the upper left portion of the diagram.

The schematic of Fig. 1 shows the 2N3823 (or TIS 34) field effect transistor cascaded in the common-gate configuration. An input tank circuit was tried and replaced by a simple rf choke to provide the rf input load. The low input impedance

into a grounded-gate configuration tends to broaden or swamp any input tank circuit. The biasing resistor is bypassed to provide the rf ground. Two 1N100 diodes were placed back-to-back at the input connector to prevent possible overload damage. Poor isolation, especially in the antenna relay, could easily destroy the input transistor.

Construction

The amplifier was mounted on a piece of copper-clad printed circuit board. The board, with the copper on but one side, is cut to length and drilled as shown in Fig. 2. The general layout may be increased if parts appear too cramped. Notches must be cut in the vertical shields for the transistor sockets. The boards and component leads

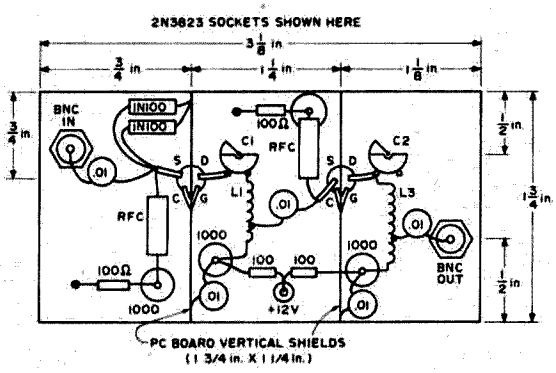


Fig. 2. Sketch shows layout of FET preamp. Note use of shield walls between stages.

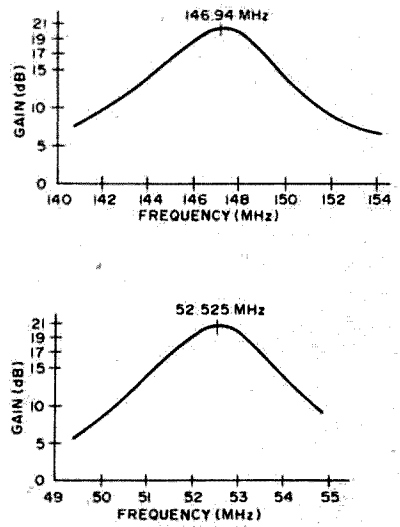


Fig. 3. Gain-bandwidth curves for 2 and 6 meter versions of the FET preamps. Note that gain peaks at about 20 dB in both instances.

are then cleaned with steel wool to prepare a good soldering surface. After the sockets are mounted, the vertical shields are soldered in place neatly and evenly using a small soldering iron. The standoff button bypass capacitors are soldered firmly to the board. All ground connections are made by directly soldering the part down on the copper.

The 2 meter coils are wound on a ¼ in. diameter rod using 8 turns of 16 AWG enamel-coated copper wire. The coils are spread to ¾ in. long and tapped 2 turns from the supply voltage end. Each 6 meter coil is wound on a 3/8 in. diameter rod using 13 turns of 28 AWG wire, tightly spaced and tapped 2½ turns from the cold end. Care must be taken when soldering the leads to the Johnson capacitors. The stator plates are held in position by solder during manufacture and may fall apart when heated. Maximum capacitance values of 5 pF for 2 meters and 20 pF for 6 meters were chosen for the variables so that they would be in their mid-position at resonance. The output tap may be varied to determine bandwidth and gain. The positions shown here are not critical, but are a compromise for broad bandwidth.

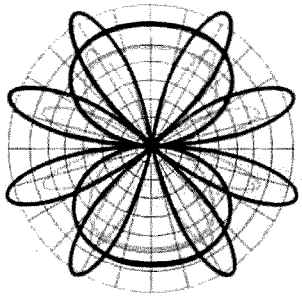
A CU-2101A Minibox is drilled to allow passage of the connectors, sockets, and capacitor shafts. The printed circuit board chassis is then bolted to the Minibox top and labeled with dry transfers or decals.

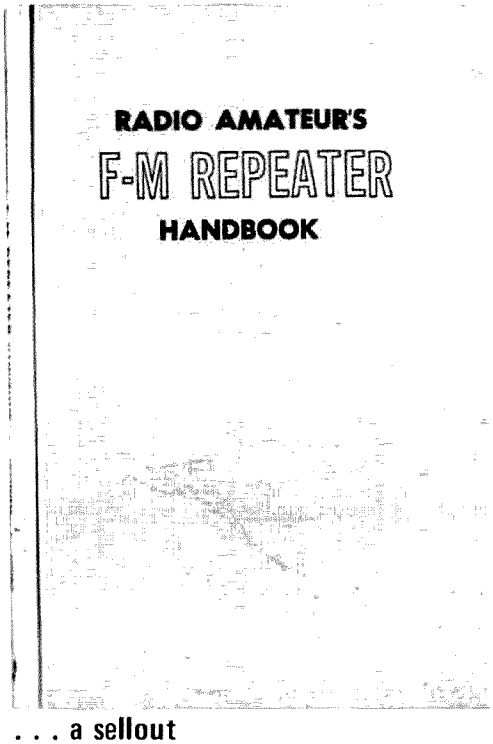
Performance

With a 12V supply, the preamp draws about 10 mA total current. The two capacitors are tuned to resonance simply by peaking on noise. Figure 3 shows the response characteristics of each preamp. From the results shown, the 2 meter

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EDUCATED

The warning or "idiot" lights provided as replacements for dashboard meters in most modern automobiles leave a lot to be desired. Two of their more obvious shortcomings are: (1) they may be illuminated for some time before being noticed, especially on a bright sunny day; or (2) they may burn out without warning, leaving the driver with no warning at all.

Taking a leaf out of the aircraft designers handbook, what is needed is a method of drawing the driver's attention to the lamps as soon as they light, as the malfunction may be serious enough to require immediate attention. The device to be described will cause the illumination of any idiot light to sound an audible alarm. The immediate disadvantage to such a system is that if the light remains on for some time (as, for example, if you have to drive some distance to a service station), the continuous sounding of the alarm could become dangerously distracting. To prevent this, an "override" switch has been incorporated to disable the alarm once it has served its purpose. However the circuit incorporates an automatic reset feature which will reset the alarm once the fault is corrected, so that the next time an idiot light comes on it will sound again without the need for any action on the part of the driver. An added feature of this circuit is that if the fault is not corrected, the alarm will come on next time the car is started: also, each time the car is started, the alarm will sound for a moment as an automatic test of its readiness.

The alarm itself (see Fig. 1) consists of a 12V buzzer, and the reset circuit is composed of a small spdt relay and a momentary-contact spst pushbutton switch. The alarm is connected to the idiot lights through a number of diodes which serve to allow the different light circuits to trigger a single alarm without shorting all the lights together.

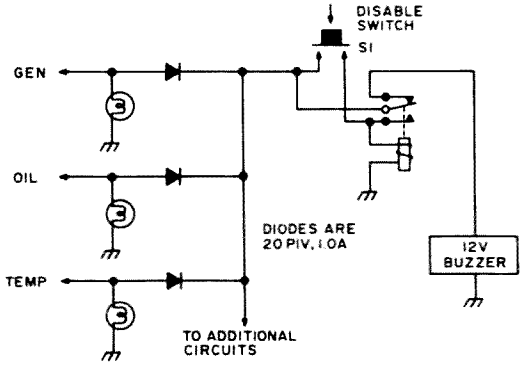


Fig. 1: Circuit diagram of audible "idiot light" alarm.

When one of the idiot lights comes on, the voltage is passed through the appropriate diode, through the relay contacts, and on to the alarm buzzer. When the driver wishes to silence the alarm he pushes the switch; this shorts the normally open relay contacts, and results in the current being diverted from the buzzer to the relay coil. The relay is now energized and holds the contacts closed, leaving the buzzer disconnected. When the fault is repaired and the light goes out, the relay is no longer energized and returns to its normal

IDIOT LIGHTS

D. J. Holford
RR 1, Enfield
Hants County
Nova Scotia, Canada

position, resulting in the buzzer again being connected to the input ready to sound off next time a light is illuminated.

The alarm is not restricted to just those functions provided by the idiot lights, and can warn of any situation capable of being indicated by an electrical signal. For example, it could be used to warn of lights being left on when the ignition is off by use of a suitable circuit.

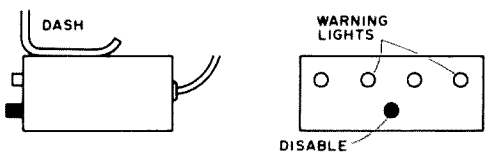


Fig. 2. Suggested mounting method and panel layout.

The diodes and buzzer can be concealed out of sight under the dash (Fig. 2), and the only item which needs to be exposed to view is the pushbutton disable switch; however, I prefer to have an integrated warning panel which saves having to look around to see which light is lit. I duplicated all the normal warning lights, plus others for the additional circuits which can trigger the alarm, and installed them all in a small master warning panel together with the disable switch.

There are a number of suitable locations for such a panel. The easiest and most obvious is under the dash, but items under the dash have a habit of getting in the way of knees. I preferred to make a small panel and install it in the center of the roof above the rear-view mirror, where all I have to do is glance up to see what happened. Another good place for those who have given up smoking is to make a small box which will fit in the ashtray space, and paint it to match the dash. Since there are very few parts, and they can all be miniature, it does not require much space.

I have not included detailed layout and construction plans as the design can be easily customized to your own car and personal desires. The circuits will all be basically the same, but the placement of components will vary. Also some may want duplicated lights and a custom warning panel, while others will conceal the buzzer under the dash, and only the switch will show.

Any small 12V spdt relay will do, plus a 12V buzzer, a pushbutton switch, and the required number of diodes. The diodes are not critical as long as they can handle about 1A at 15–20V. There are a multitude of diodes and relays available at low prices so the constructor should have no problem obtaining parts.

Construction and installation can be easily accomplished in one evening, and the result is an impressive and effective addition to any automobile.

If you decide to add the duplicate lights, you can obtain small self-contained 12V pilot lights at the local radio store for a small sum. One final point to remember: The diodes must be insulated from ground, as both sides are carrying 12V.

. . . D. J. Holford ■

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Honest Injun . . . you can build one in your cigarette lighter!

You can really hide this one, even in the skin of a bear! It's only ¾ x ¾ x 1/8 in., is crystal controlled, puts out up to ¼ watt on 6 meters, and can be used for biological work, survival units, etc. With a 6 in. antenna I've heard it out to 15 miles.

This article describes what can be done on VHF today with off-the-shelf subminiature items. Of course you do have to look hard for some of those shelves – but they *are* available.

The Crystal

As far as I know McCoy is the sole manufacturer of a suitable crystal less than 1/8 in. thick. McCoy has a special glass blower (from the Old Country?) who encloses the tiny little crystals in glass. These gems work, and work extremely well. I've even run 15 mW through the crystal itself and so far no trouble.

Figure 1 shows a sketch with dimensions of this jewel in its Type MM glass package. Of course they don't just give them away, but where else can you get one 110 mils thick? There is still the next size up, the M20, with a "tin can" holder which is 183 mils thick, if you have the room.

I recently acquired two of the MM units and they both worked immediately in the circuit shown in Fig. 2 and have continued to work ever since; so they aren't just pieces of costume jewelry.

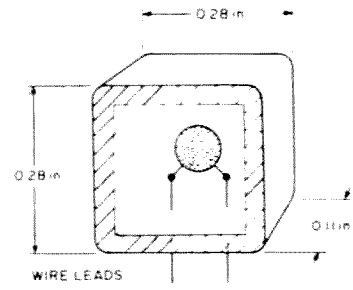
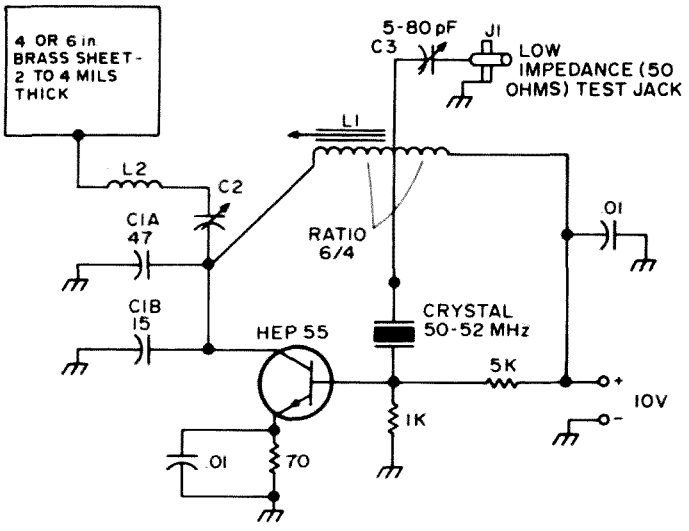


Fig. 1. McCoy's Type MM crystal is an incredibly small element enclosed in a tiny glass package not much larger than a thick-film capacitor chip. Less that 1/8 in. thick, the area of the crystal is about ¼ in. square.



NOTES:

1. "Ground" is the copperclad baseboard plus the battery.
2. J1 should light a No. 48 or 49 pilot light bright.
3. L2 will vary with antenna size.
4. Check final tuning carefully with CIA and CIB compared to a No. 463 Arco mica trimmer, 10 to 180 pF.

Fig. 2. Even though the transmitter packs down in density to about the size of a postage stamp, the circuit is straightforward and without surprises for the builder.

Transistor

Just for fun you might say, I soon tried the Motorola HEP 55, but after checking against others of the same size or smaller, I stayed with it. After all, it's only $1.20, it is plastic, and can easily be filed down to the desired 1/8 in. thickness. The plastic takes up about a third of the overall thickness of these little powerhouses, so you can easily file down to .125, a little on each side. I also checked out several dozen of them for "activity" in the circuit of Fig. 3.

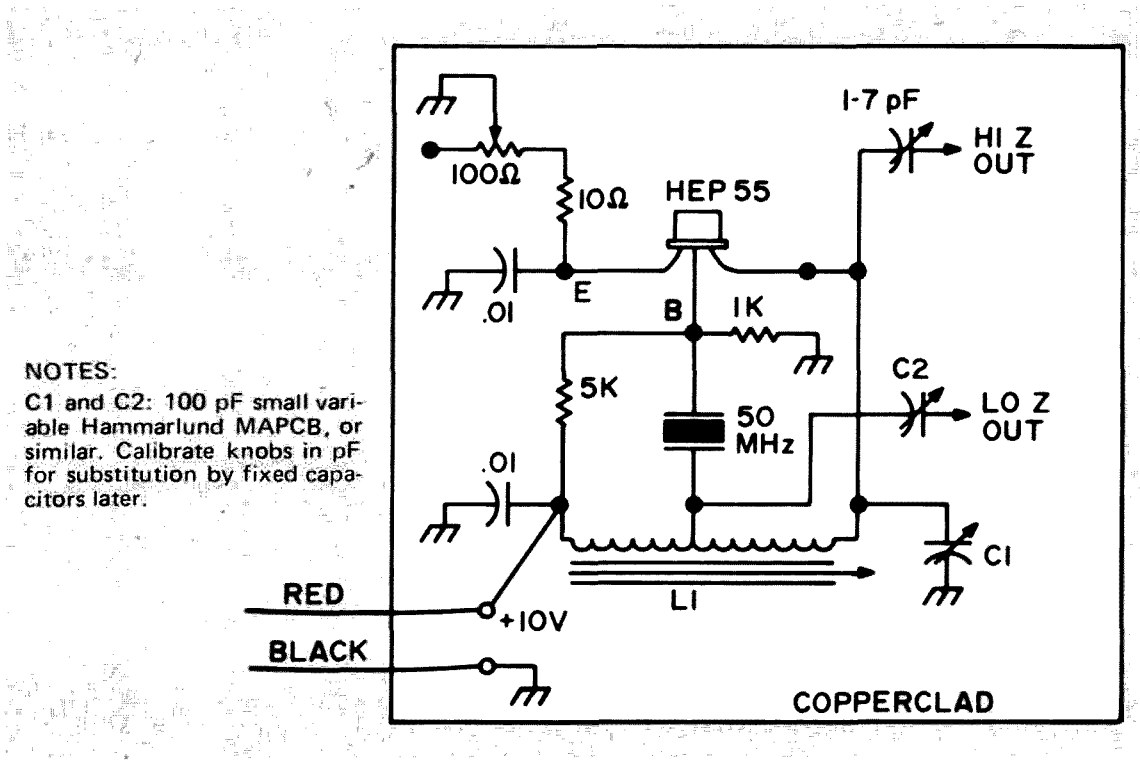


Fig. 3. Breadboarding the transmitter into a test configuration with regular-size component will give you the chance to get the "feel" of the circuit and its capabilities.

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by grading them as *very good*, *good*, and *fair*. I got about 10 in the *very good* category. The rest go fine in i-f circuits, so that settled that question.

I have run 45 mA at 10V for hours at a time, getting over 200 mW output of rf with no trouble of any kind; so there's no need to fear pushing a little if you have a few extra on hand.

Coils

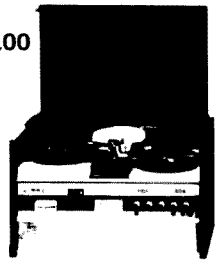
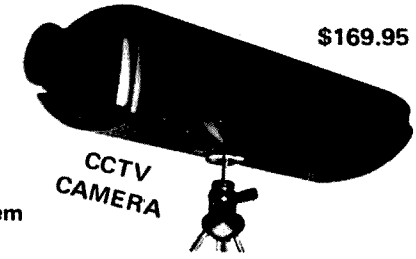
There are two coils, one of which is for loading the 6 in. antenna. Made by Piconics, a suburban Boston company, the coils are tunable and tiny (less than 1/8 in. thick). The tunable feature is one of the major advantages of these coils because, as far as I know, there are no variable capacitors in existence less than 1/8 in. thick.

Just to see what effect the tiny coil size had on the power output, I cut it down and kept cutting down until I reached the size of a piece of spaghetti about 80 mils diameter, wound with 34-gage wire. Even though I squashed it almost flat, the output power remained the same. When the circuit is properly tuned and loaded the coil really doesn't make much difference. Once again, the influence of the matched circuit and the loaded Q! If the proper amount and phase of feedback is there, which it is in this case, the rf output almost burns out a No. 48 bulb.

The circuit tunes broad but correctly and smoothly, and stays exactly on 50 MHz, or 50.4, or on whatever frequency the crystal is ground for. It also stays on the air, which is very important. As usual with any crystal oscillator, load it up to where it does go *off* the air, and then unload it so that it stays *on* the air with whatever battery voltage you may choose to use as the end of the battery life.

Breadboard Test

Use the test jig of Fig. 3 with large variable capacitors for tuning up and checking out the subminiature components *before* you mount and solder them into the tiny "chassis." I found that 15 turns of wire (32 or 34 AWG) with the crystal feedback tapped on at 5 turns from the low end was very good. Ten turns of 26

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AWG on a threaded paper form was handy to start with, and sure-fire for use on 6 meters.

If you calibrate the knobs on the variable capacitors you can then substitute fixed values later when you get down to the subminiature size, and do the tuning with the Piconics coil. This tiny wonder, shown in Fig. 4, actually has a core which moves in and out by means of threads in its nylon holder. Don't forget, you've got to tune *something*. It is possible to substitute fixed values of capacitors and make it work, but I'm assuming you've handled enough transmitters to know the value of tuning up. A good Piconics coil for 6 meters is the one labeled B121K713Y1. That's quite a mouthful, but it not only indicates the inductance but the ratio of the tap position as well – just be happy

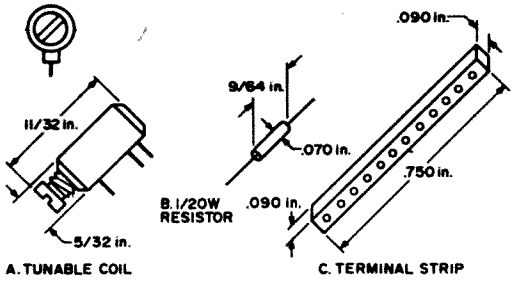


Fig. 4. Layouts and dimension of some of the "micro" components in the postage stamp transmitter.

that someone makes one that's on the shelf ready for you.

Resistors

Sprague Electric, Nashua, N.H., makes good 1/20 watt resistors. They are precise and tiny, and they work. Figure 4 shows dimensions. 'Nuff sed.

Capacitors.

Republic Electric makes capacitors up to the .01 μF value used here. They have a maximum diameter of 60 mils. That's under 1/16 in., in case you haven't been in a machine shop lately. Every one of these skinny cylinders has worked properly. I don't know how they do it but I'm going to find out soon with a visit down into the wilds of Patterson, N.J. to see for myself.

Mounting Strips

I really had to turn on the old imagination for this one. Past readers may recall my frequent use of .021 "common pins,"

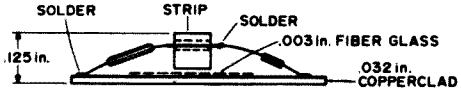


Fig. 5. Side view shows terminal strip utilization and mounting technique.

brass, nickel plated, for terminal strips, hammering them into 20-mil holes in fiber glass strips or linen-base Bakelite. Well, these are too big for this job! So I cut up some of the linen-base Bakelite stuff into square cross-section rods and drilled through the sides of them, as in Fig. 4C.

Figure 5 shows the drilled strips, or "logs," with a small strip of 1½- or 3-mil fiber glass under it for security against ends of components or wires shorting to the base plate, and examples of components used. You can drill as many holes as you have wires or solder two or more wires together on one side of the strip.

Chassis

Figure 6 shows the baseboard cut out to receive the major components, which are the coil, the crystal, and the transistor. As these units are over 100 mils thick they cannot be mounted on top of the baseboard but do very well in the cutouts with coil cement or other types of embedment added later. Although I am showing one example of a circuit with the 1/8 in. thick technique, you can of course use the same method for other circuits. I have gone up to 432 MHz with this type of construction, so various things can be done at the 1/8 in. thickness. After mounting and soldering, you can also use high-temperature coil wax for a test unit which you might want to change later. This can also be used for a "next to final" model.

Batteries

In my quest for a really tiny battery (1/8 in. thick), I found that only two qualified

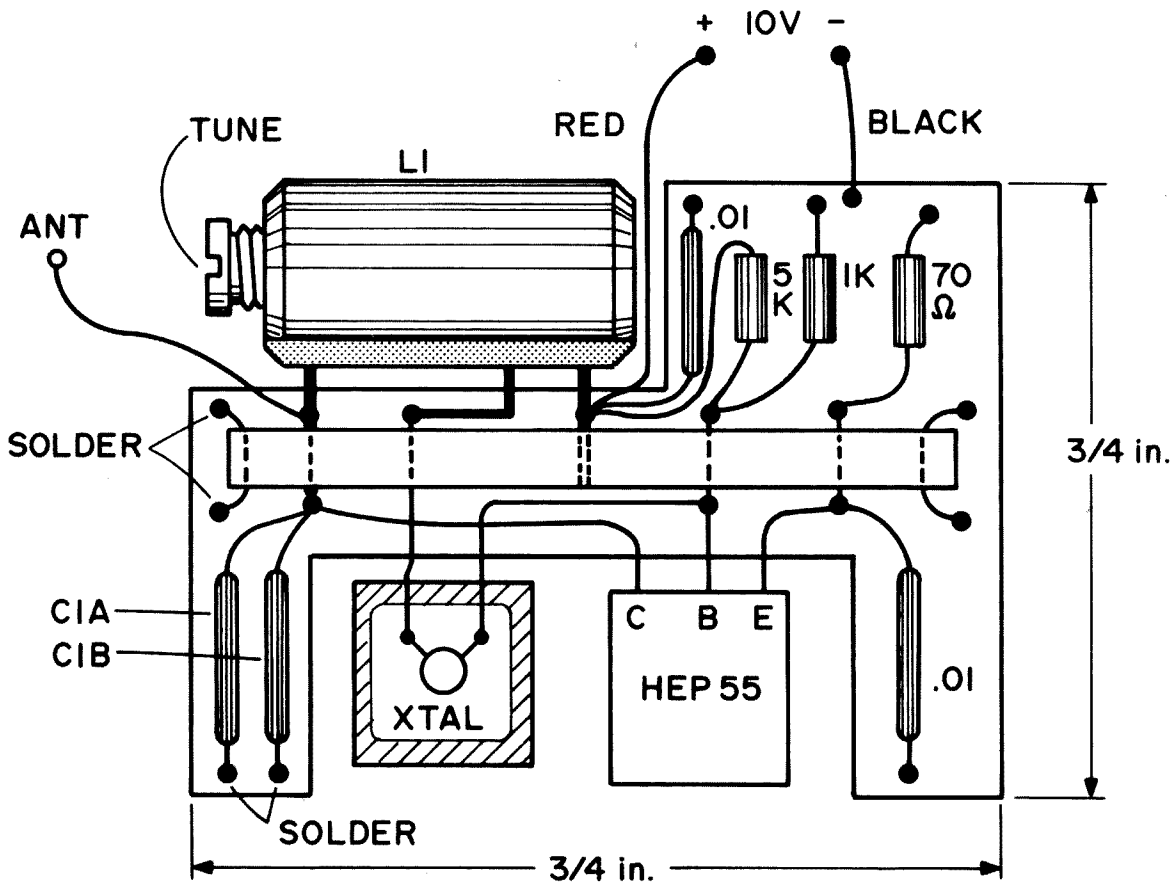


Fig. 6. Blowup top view shows layout of subminiature oscillator. Actual physical size of unit will be 3/4 in. square.

as "desirables," and one of these was ultimately eliminated by testing. The two candidates were the *silver oxide* and the *mercury* types. The dimensions of the smallest is shown in Fig. 7. For up to about 100 mW output, with a battery drain of about 20 mA at 10V, a check was made on the above types. The silver oxide battery lasted 30 minutes and the mercury battery 65 minutes. Of course, these tiny power sources are *not*, absolutely *not*, sold for any such use. In fact, the engineering department heads of the two largest battery companies tend to either raise their voices or hang up the phone, or both, when they find out what you really want out of their little aspirin pill batteries.

There are two immediate solutions: reduce power, or reduce the time on the air. For some uses – such as continuous monitoring with voice or other sound modulation – you have to reduce power for any reasonable life at all. This can be done very simply by using less battery voltage or increasing the resistance of the emitter resistor, or both, and a slight amount of retuning. For some other types of uses, such as biological tracking, hidden transmitter hunts, etc., you can turn the rig on for short periods only; for example, 10 msec out of every second for an increase in battery life of *better* than 100 times. (There is nothing worse for battery life than a constant heavy drain.) This type of automatic keying is, as usual, another story. The tiniest little transistors, the Microtabs by GE, can be used for this service in a multivibrator circuit to drive another one of them in a simple on–off switch type of hookup.

For the battery pack, a 1/16 in. sheet of soft plastic such as PVC (polyvinylchloride) can be used to hold the batteries in a pack of four, six, or eight (or even ten

if you like "high power") as shown in Fig. 7. If you order a large quantity, Mallory will *weld* tabs on each pill-size battery and you can then solder them together to make up a pack. Count on no more than 1.0V per cell, regardless of the drain you may expect, because they will soon enough reach this level, or even lower, unless you operate in a pulse mode.

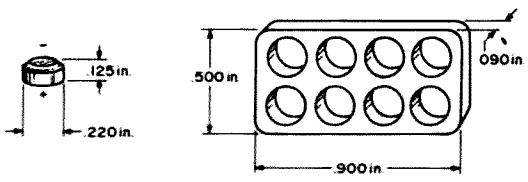


Fig. 7. The tiny battery can be used with other batteries if a holder is constructed from PVC as shown here. (Holder shown accommodates eight batteries.)

For test operations I did solder leads onto them, much against the advice of the engineering departments of the battery companies. So far, no ill effects, but you have to do this *very* carefully. I used a 25W iron well cleaned and tinned, shined up the battery case first, and then tinned it. A touch of perhaps less than one second does the trick, also using very-small-diameter solder. I am *not advising* this method, just mentioning that I did use it! Also, use flexible subminiature wire such as multiple strands of 34 AWG, for example, with Teflon insulation. These batteries can be purchased where hearing aids are sold and in many radio stores. Naturally, use the largest size you can put into your project. The "aspirin" size will only give a life of 12 mA-hr at something like a 1 mA drain – *not* enough to operate the oscillator. It will run at around 4 mA, though. This power level is easily adjustable by the emitter resistor, as mentioned before. You can generally expect about 50% efficiency for dc input to rf output power with the circuit shown in Fig. 2.

Circuit

When I first made up this design I was looking for a foolproof crystal circuit, one that would not take off on any frequency other than the one marked on the case. The circuit shown achieves this goal; after working with it some time, I find that it can be a very powerful oscillator as well – stable and reliable. In a later 73 article (*Solid-State Power on Six*) you will see it running at over a watt, with up to 500 mW output!

How it works

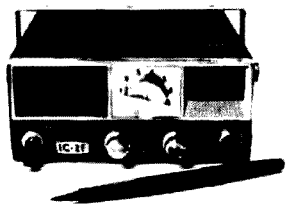
Referring to Figs. 2 and 3, when the collector is tuned to 50.4 MHz, for example, by C1 and L1, with 10V in, a volt or so on the base, a bypassed resistor from the emitter to ground, and a 50.4 MHz crystal connected between the base and the tap on L1, it *will* oscillate. It's a law of nature! Note that the feedback looks as though it was degenerative, or negative. It only looks that way though, because the crystal reverses the phase of the feedback voltage going to the base. This is a fact of life very difficult for some engineers to swallow but it works! Even the Curies in France in the last century knew that much about peizo-electric crystals.

The result is advantageous. With positive feedback coupling, the oscillator can be quite critical for the right amount of feedback, tuning, and loading. With negative feedback coupling, it will only oscillate when the crystal reverses the phase, which of course occurs only on its proper and marked frequency. Just how many half-waves of sound are standing across the crystal is the concern of the manufacturer, as long as these sound waves inside produce 50 MHz electromagnetic waves on the outside, and vice versa of course.

Crystal Power

I think this is a matter to be decided by usage because, while the makers talk about 2 or 3 mW of power in the crystal circuit, I found that a small pilot bulb in series with a 50 MHz crystal lights up a little on the 1W oscillator. In the CW mode you will not run that much, but with pulsing you may well go over it. About 10 to 12 mW is required in the transistor base–crystal circuit for about 500 mW out at the collector circuit. You can see that the gain of the transistor is important also.

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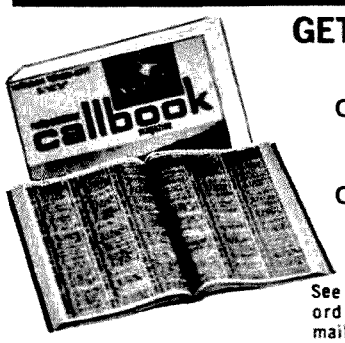


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In the "Good Old Days," a pilot light was regularly installed in series with the crystal. Granted, those were big fat crystals, on 160 meters, etc., while we're talking here about a real skinny one, for 50 MHz. After all, a wave, even if it's a slowpoke one like a sound wave, doesn't go very far if it has to stop after one fifty-millionth of a second. So you can take your choice as to the power you run. You can see that the more lively the transistor, the more power you can run from an oscillator with a given crystal's *rf milliwattage*.

Antenna

The tiny 6 in. antenna's performance was a surprise to me even after half a century in radio. Using the antenna and loading circuit shown in Fig. 8, I left the rig in a house in Jaffrey, N.H. and could still hear it in Francestown, more than 15 miles away. On 6 meters, this is an antenna of about 1/36 wavelength long. You can be surprised or not, as you please. I was. The

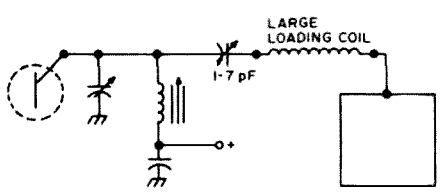


Fig. 8. Although several antennas and loading techniques were tested, the approach shown here proved significantly superior.

only disadvantage of the antenna loading technique shown is that you need close to the right number of turns on L2; other loading techniques may be less critical, but experiments have shown that they are not as efficient when it comes to rf radiation.

Receiver 1

First, you need a diode field strength meter for use at a fixed distance, say a foot or so to start with, in order to tune up and compare radiated power. I soon found that the best setup was another short antenna clipped onto the diode detector's tuned circuit about halfway up the coil (Fig.9). For meter indication at maximum distance, the length of the whip and its contact position along L1 are important.

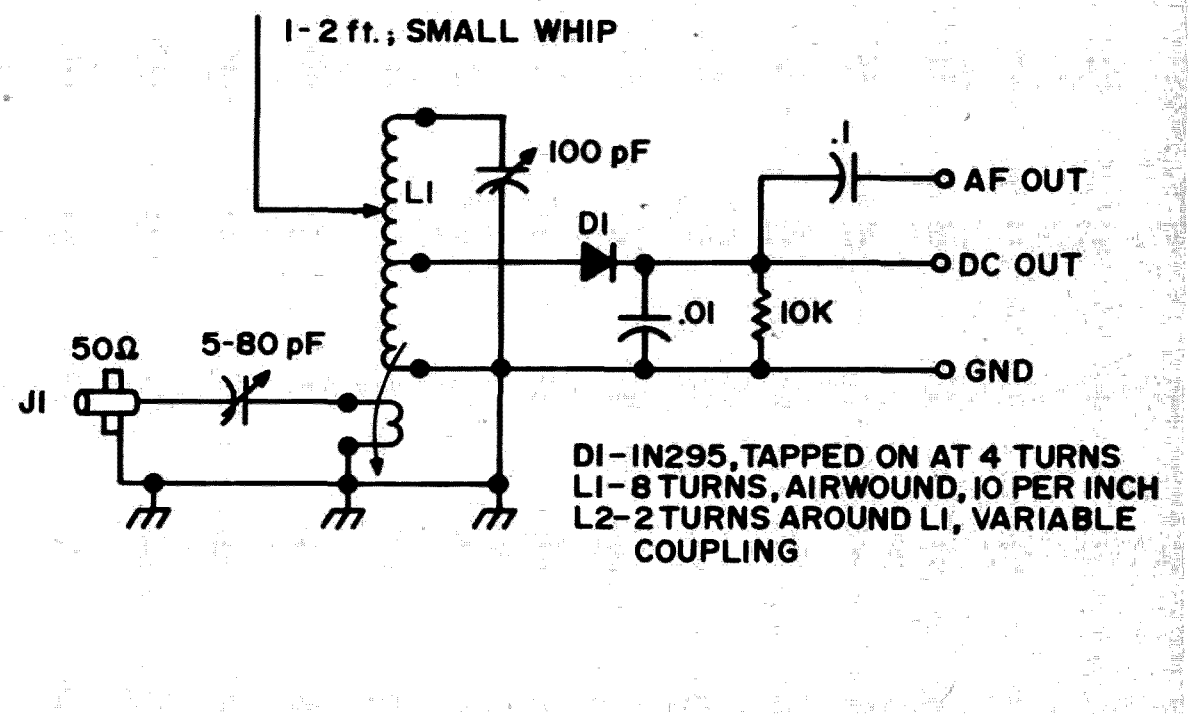


Fig. 9. A diode detector makes a convenient and useful receiver for checking the performance of your postage-stamp transmitter while it's on the bench.

Figure 9 shows the circuit I used, which is also a good frequency meter for checking to see if you *are* on 50 MHz and not on some harmonic. *Never* rely on a high-gain receiver for this basic fact. Use it to check for noise, hum, stability, etc. once the frequency has been determined.

Polarization can also be checked with the diode receiver by using a regular 50 MHz dipole (or beam if you can handle it physically) across the room, or outdoors if needed, with its matched cable plugged into J1 (Fig. 9).

Receiver 2

I put some tone modulation on the rig to identify it because at a distance of 15 miles I wanted to be *sure*; but of course you can use plain CW with a bfo if you like. Either way, the signal comes in great with a regular receiver and beam on 6 meters.

For a particular purpose in mind I did build up a good hand-carried receiver for use with these little rigs. This is a semi-fixed-tuned job with small knobs on the tuning capacitors for test purposes – it tunes over the band in great style. The front end has a 1.7 dB noise figure, which is very useful because you can take it to absolute "hermit" locations, where such performance really *counts*. But, of course, that is a completely different story, and will be published later.

List of Component Manufacturers

Transistor: Motorola HEP 55
Coil: Piconics, Tyngsboro, Mass.
Crystal: McCoy Electronics, Mt. Holly Springs, Pa.
Capacitors: Republic Electronics Corp. 176 E. 7th St., Patterson, N.J.
Resistors: Sprague Electric, Nashua, N. H.
Insulation: Insulating Fabricators, Inc., Watertown, Mass.

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Getting Your Extra Class License

STAFF

Part XVI: RF Power Amplifiers

In the previous installment of this Extra Class study course, we began a discussion of some points of transmitter operation included on the official FCC study list of questions. This time, we'll conclude our look at the subject of transmitter operation.

In the process, we'll examine the following FCC questions:

40. How can the output circuit of a transmitter be adjusted to increase or decrease its coupling to the antenna system?

50. What would happen if the grid-bias supply of a Class C modulated amplifier was suddenly short-circuited?

61. What are some causes of the excessive production of harmonics in rf amplifiers? How can these causes be remedied?

62. What effect does a transmission line which is not properly terminated have on the plate tank circuit of a transmitter?

78. Give some proven methods of harmonic reduction in transmitters.

We'll follow our usual practice, and rather than providing specific answers to these specific questions, rephrase the questions into new queries with broader scope so that the general principles underlying the details can be brought out.

These five questions group into three broad subjects—harmonics, antenna circuit interaction with the transmitter, and effect of losing grid bias.

And as it happens, all three subjects are parts of the general subject "What Goes On In The Final Amplifier?"

Unfortunately, *that* subject is much too broad for us to examine in any detail, so we'll have to strike some medium. We can start by asking "How Can Harmonics Be Controlled?", which will wrap up FCC questions 61 and 78. This will also tie directly into another question, "How Does the Antenna Circuit Affect the Final Stage?", which will take care of FCC questions 40 and 62 among other points. Now we have only the FCC question 50 to cover, and we can get it by asking "What Happens in a Modulated Amplifier?" Actually, a large part of this question was answered in our previous installment, but question 50 is one which can be rather tricky as it has no single specific answer, so it's worth going into again.

By this time, we'll assume that you have been following this course for some time, and we'll assume that you already have a pretty fair idea of what goes to make up the final rf stage of an AM, FM, or CW transmitter. What we have to say here also applies, with some exceptions, to SSB linears—but we've already discussed them as a species apart.

Ready to explore the depths of the harmonic problem? Let's get under way.

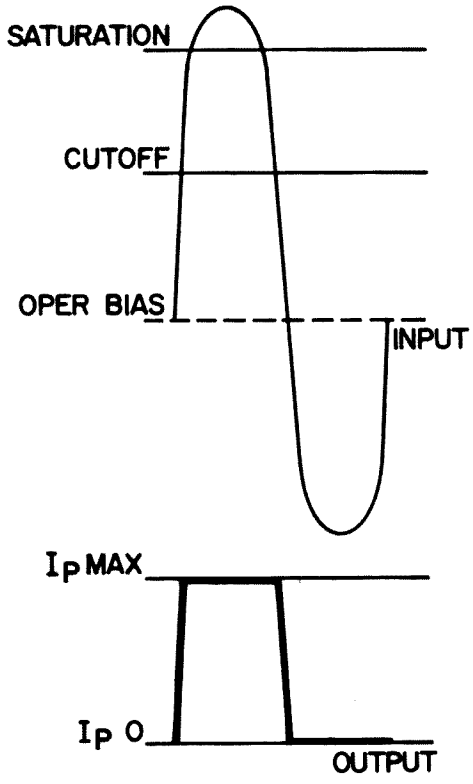


Fig. 1. Class C waveforms.

How Can Harmonics Be Controlled? We have only two avenues of attack in any effort to control harmonics—one is to prevent them from being created in the first place, and the other is to prevent them, once created, from getting out of our transmitters.

It might appear simple, at first, to operate an amplifier in such a manner that no harmonics were generated. And it might actually be simple, if there were any such thing as a *perfect* amplifier. We, however, must get by with imperfect amplifiers and their resulting distortion—and any form of distortion involves the creation of at least a small amount of harmonic signal.

Even if we had perfect amplifiers, the only possible harmonic-free amplifier would be one operating in Class A. This would, in itself, rule out the harmonic-free amplifier for any appreciable power level in transmitters, because Class A amplifiers are only about 25% efficient at best. To produce large amounts of rf energy and stay within our power limits, we must use Class B or Class C circuits.

And by the nature of their operation, Class B and Class C amplifiers are prolific generators of harmonics. The Class C amplifier, in particular, clips off its input signal sharply at the bottom when cutoff level is reached, and equally sharply at the top when the amplifier's saturation point is reached (**Fig. 1**). The result is that only a small pulse from the original input signal gets through the amplifier. Any pulse with sharp corners contains a large amount of harmonic energy; the sharper the corners, the more high-order harmonics are present (the limiting case of this is a perfect square wave, which contains the fundamental and all the odd-order harmonics out to the umpty-umpth).

If we reduce the level of the input signal to avoid saturation, and decrease the grid bias so that cutoff isn't reached quite so rapidly, we can reduce the sharpness of the clipping action. But while we're doing so,

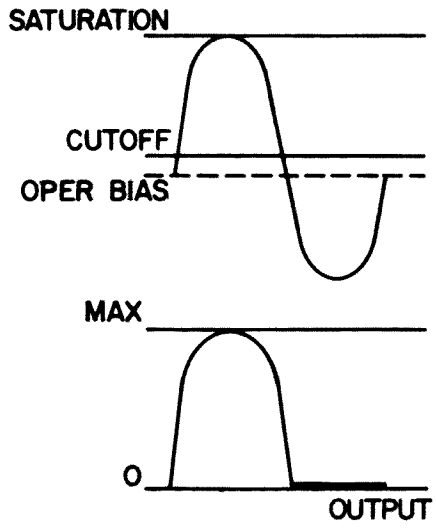


Fig. 2. Class B waveforms.

we're changing the amplifier from Class C to Class B operation (**Fig. 2**) and reducing its efficiency. When we have completely eliminated the saturation-point clipping, and moved the cutoff clipping point down so that we get the positive-going half-cycle of input signal through to the output and lose only the negative-going half-cycle, we have a true Class B operation.

If we keep reducing bias until no clipping at all occurs, we can get rid of much of the harmonic energy—but we will have converted our amplifier to Class A (**Fig. 3**) in the process and our efficiency is virtually gone.

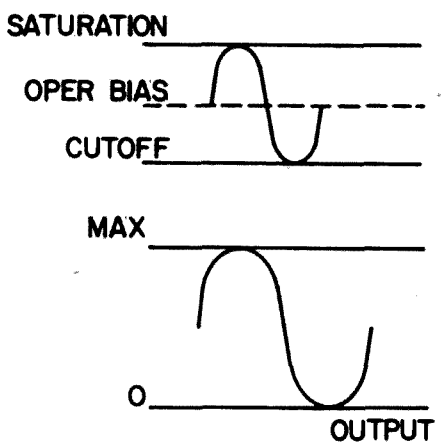


Fig. 3. Class A waveforms.

The point is that the high efficiency of the Class C circuit has its price, and that price is the high percentage of harmonic energy present in the output. In fact, most if not all of the added power in a Class C amp's output (as compared to a similar circuit and input power operating in Class A) is composed of that harmonic energy!

What saves the day for us and makes the Class C circuit practical is the selectivity of the plate tank circuit. Like any other tuned circuit, the plate tank rings readily at its own resonant frequency, and tends to bypass all other frequencies. In the process of bypassing the harmonic energy, it is temporarily stored in either the magnetic or electric field of the tank, and adds to the output power at the fundamental frequency.

When we use the phrase "fundamental frequency" here, we mean the frequency to which the plate tank is tuned, which is not necessarily that of the input signal.

A case in point is the "frequency multiplier" circuit so necessary to VHF and UHF transmitters. This is, in essence, just a Class C amplifier in which the output tank is tuned to some harmonic of the input frequency rather than to the input frequency itself.

The efficiency of the frequency multiplier is low, compared to that of a "straight-through" amplifier, because as the harmonic order rises, the amount of that harmonic present in the plate waveform falls. Thus a two-time multiplier is about half as efficient as a straight-through circuit, a 3-time multiplier about a third, and so forth.

To get the maximum efficiency out of a multiplier, we change its operating conditions just a little from those for a straight-through circuit. The most major change is to increase the grid bias. This increases the clipping action at cutoff, and boosts the harmonic content of the output by making the clipping more sharp.

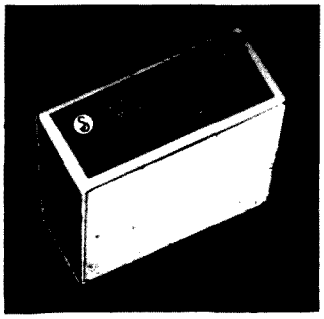
We can take a trip from this to find ways of reducing the harmonic content of a Class C amplifier's output. Reducing the grid bias to the lowest level that will permit desired operation will help cut down the harmonics, as will trimming grid drive back to the lowest necessary level. And by all means, we should make certain that our plate tank circuits are tuned to the desired frequency. It's not too uncommon for Novices to accidentally tune to the wrong dip, but that's not what we're talking about so much as the possibility of an unwanted additional resonance at or near some high-order harmonic such as the seventh, ninth, or eleventh. Such a resonance can result in a surprising amount of harmonic output from an otherwise clean transmitter. Careful probing of tuned circuits with a dipper is the best test for such goings on.

Since the selectivity and flywheel effect of the plate tank circuit in a Class C amplifier is the only thing standing between you and an overdose of harmonics, the tank circuit itself is a key factor in harmonic prevention.

For best selectivity, and the companion condition of minimum harmonic energy, the Q of the plate tank should be high. Like the matter of circuit efficiency versus harmonic

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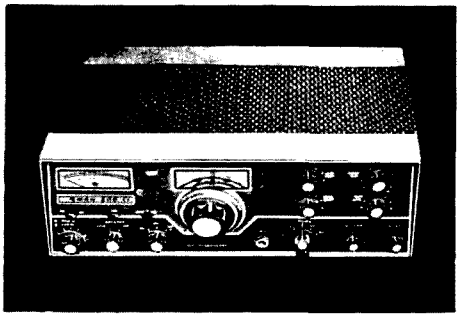


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generation, though, this is only one side of a tradeoff. High Q in a tank circuit means that the current circulating in the circuit will also be high; the circulating current in any tank with appreciable Q is equal to Q times the current going through the circuit to outside. That is, if your final is operating with a rms rf current of 100 ma (relatively low for a transmitter, since with a 600-volt supply this is only about 60 watts of rf), then if the tank circuit Q were equal to 100 the *circulating* current in the tank would be 100 x 100 ma, or 10 *amperes*. If the resistance of the coil were only 0.1 ohm, the power lost in this resistance would be I^2R, or 10 x 10 x 0.1 watts, which works out to 10 watts—or nearly half of the total power produced by the amplifier!

Reducing the tank circuit Q to 10 in the preceding example would reduce circulating current to 1 amp, and the lost power would drop to 0.1 watt; cutting Q to 1/10 its original value trimmed the loss to 1/100.

So for minimum loss in the tank circuit, Q should be low, but for minimum harmonics, Q should be high. In practice, the Q of the tank is chosen as a compromise between these conflicting requirements, and normally lies in the range from 10 to 20 (Fig. 4). A Q of 10 is about the minimum capable of providing decent harmonic rejection, but at frequencies above 21 mhz it often proves impossible to get down this low and a figure as high as 20 must frequently be accepted as the minimum possible value.

Note that these Q figures are the *loaded* Q of the complete tank circuit; don't get them mixed up with the Q ratings of the tank coil alone. The *coil's* Q must be as high

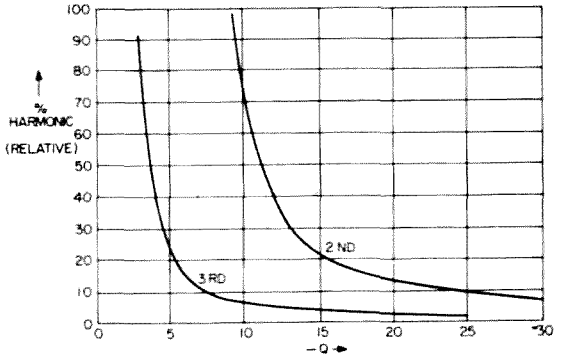


Fig. 4. Relative harmonic reduction for various plate circuit Q values.

as possible in order to keep losses down. When the entire circuit is hooked up and loaded to the desired output level, it behaves as if a resistor were connected in parallel with it. This resistor (fictional, of course) is how the output power is accounted for in the circuit equations, and the "loaded Q" about which we're talking is the ratio of this fictional resistor and the reactance at resonance.

If loaded Q is too small, harmonic problems are not the only troubles to be expected. The circuit will also prove difficult to couple to a load. Loaded Q can be increased by reducing the inductance in the circuit, or increasing the capacitance. The loaded Q of a final-amp tank will also vary with the coupling to the antenna: all calculations are based on the assumption that the amplifier is delivering its intended output power level. If more lightly loaded, Q will be higher, and if overloaded, Q will drop.

Since each tuned circuit adds additional rejection of off-frequency signals while having little effect on signals at the resonant frequency, the more tuned circuits you have, the smaller will be the harmonic content of the output. This is an excellent reason for use of antenna tuners. Harmonic filters, about which we'll have more to say a little later, are in the final analysis merely special kinds of tuned circuits.

Because additional tuned circuits offer additional harmonic rejection, any transmitter making use of frequency multiplier stages (which means, in practice, almost any transmitter except a sideband rig) should have the multipliers as early in the lineup as possible. This permits the maximum number of tuned circuits to follow them, thus attenuating the unwanted harmonics produced by the multipliers while strenghtening the desired output frequency.

The multipliers should also be operated at the lowest power level practical for them; all power gain should be achieved in straight-through stages if possible. At VHF and UHF, this is not always practical, due to the difficulties of attaining large amounts of power amplification at these high frequencies, but in hf transmitters the rules are to keep the multipliers early in the lineup, and operate them at low power.

So far we've examined only the theoretical and design considerations involved in minimizing harmonics. Construction practices, however, are of at least equal importance. Since it's impossible to avoid having at least a little harmonic energy inside a transmitter, and the theoretical cures are based on keeping it inside without permitting it to be radiated, the construction must contribute to keeping the harmonics sealed up.

One of the first steps is to employ adequate and carefully installed bypass capacitors on all signal return paths, since the unwanted harmonic energy must flow through a complete circuit and a poor bypass may permit the harmonic to find an easier path out by means of the normal output circuit. If the lead inductance of these bypass capacitors cannot be made negligible by reducing lead length to almost zero, then it should be adjusted to form a series resonant circuit to ground at the frequency of the most troublesome harmonic. This will minimize that one harmonic, at least.

A companion step, equally necessary, is to shield all rf stages adequately. To be adequate, the shielding must be complete. No gaps must exist through which harmonic energy may leak outside the rf section. This means not only that meter holes and the like must be shielded, but that all joints in the shielding enclosure be rf-tight. Finger stock or metallic sponge is usually necessary at all doors or other openings in the enclosure in order to meet this requirement.

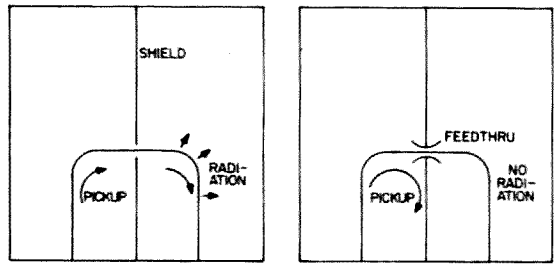


Fig. 5. How wires through shielding defeat the shield, and how to cure them.

Before shielding can be considered complete, all sources of leakage through the shielding must be plugged. This includes all wires going through the shielding (**Fig. 5**). Any lead passing through the shield should

be appropriately filtered to be certain that it carries only the *desired* energy through, and that all *undesired* energy remains trapped inside the shield. This means careful bypassing of all dc and power conductors (often using coaxial or feedthrough capacitors where the conductor passes through the shield), and appropriate filtering of signal leads.

When shielding is complete, nothing but dc and power can get into an rf enclosure, and nothing but rf at the desired output frequency can get out. What is more, the only way this rf can get out is through the antenna connector (even the antenna connector is considered to be a gap in the shielding—the shielding is kept complete by the coax shield when coax feedlines are used).

Complete shielding helps keep a transmitter from radiating harmonics through undesired ports, but does nothing in itself to reduce the quantity of harmonic energy present in the output signal. To reduce the amount of harmonic energy going out through the antenna connector, several more points of circuit design and construction should be considered:

The various stages can be coupled by any of several means. One of the most convenient, and so one of the most often used, is "capacitor coupling" where an rf choke or a tuned circuit offers high impedance to the signal in the output circuit of the preceding stage, and a capacitor provides a low-impedance route for this signal to the input circuit of the following stage. This circuit, shown in **Fig. 6**, is one of the least desirable

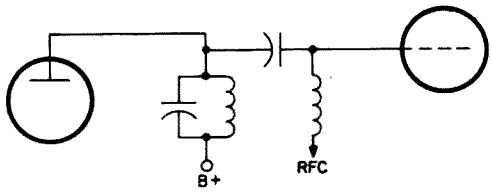


Fig. 6. Capacitor coupling between rf stages.

of all means of coupling so far as harmonics are concerned, because harmonics can couple from one stage to the next even more readily than can the desired signal when capacitor coupling is used.

Several other means also exist for coupling stages. One is "link" coupling, where the output of the preceding stage is coupled to a pickup link which is in turn connected to a second link, and the second link couples to the input of the following stage as shown in **Fig. 7**. This circuit discriminates against harmonics, because the coupling is most effective only at the frequency to which the two tuned circuits are tuned.

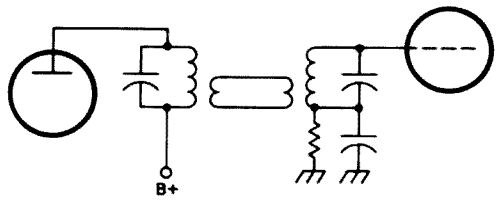


Fig. 7. Link coupling.

Another method is shielded inductive coupling, shown in **Fig. 8**. Here, the two tuned circuits are coupled directly to each other rather than through links, but an electrostatic shield between them (the "Faraday screen") blocks any capacitive transfer of harmonics from one to the other.

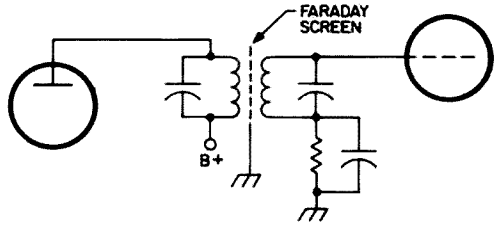


Fig. 8. Electrostatically shielded inductive coupling.

Combining these two methods gives us "shielded link" coupling, which is particularly effective against harmonic transfer. It is the same as link coupling, except that each link is electrostatically shielded from its associated coil. Unfortunately, this technique is often considered too cumbersome for ham use.

Possibly the most effective of all interstage coupling schemes, so far as harmonic rejection is concerned, is the use of a pi-network as shown in **Fig. 9**. The pi-network is, in essence, a low-pass filter and so it tends to actively filter out all harmonics. At the same time, it provides an effective coupling path for the desired signal. If designed properly, it can provide as effective coupling as any other system. However, it does require careful design or it will not transfer as much signal energy as the

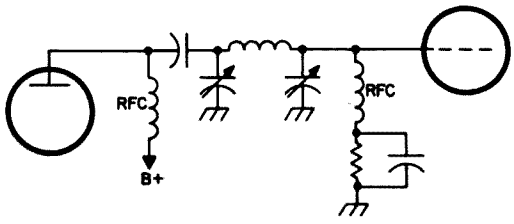


Fig. 9. Pi-network interstage coupling. Note resemblance to low-pass filter circuit.

simpler forms. This apparently the main reason it has not found more use in ham circuits, the majority of which use either capacitor or inductive coupling with no particular effort to minimize harmonics.

Once the harmonic energy reaches the output connector of the transmitter, it's still not too late to keep it from being radiated. Adding tuned circuits by means of antenna couplers will reject some harmonic energy. Most hams, however, use low-pass filters in the feedline. These filters reject all energy above their cutoff frequency.

Low-pass filters of the most common design are effective against those harmonics which cause TVI, but have little or no effect on such things as out-of-band harmonics at lower frequencies (such as the second harmonic of a 3990 khz phone signal at 7980 khz, outside any ham band).

A less common design called the "Harmoniker" consists of a half-wave trap filter, and works very much like a set of tuned circuits to pass only the fundamental signal and block all other harmonics. The disadvantage, to the operator, of such a filter is that each such filter is effective for only a single band. When the band is changed, a different filter must be put into the line. The ordinary low-pass filter, with its cutoff frequency in the neighborhood of 45 mhz, permits all signals in the hf ham bands to pass and so need not be changed for operation from 3 to 30 mhz.

No discussion of harmonic control could be complete without some examination of the final "filter" in the transmitter system—the antenna itself.

An ordinary dipole antenna is effective only for the band for which it is cut (although the ordinary dipole is also usable to a lesser degree at the third-harmonic frequency as well). Many other antenna designs share the "single-band" characteristic of the half-wave dipole. Use of such single-band antennas provides a final filtering action against unwanted harmonics, since even if they are generated and get through all the other filters and tuners up to the antenna itself, they still will not radiate efficiently.

Multi-band antennas, on the other hand, offer no such filter action. Since the ham bands are in harmonic relation to each other in the hf region (even 21 mhz is the 3rd harmonic of 7 mhz), any antenna capable of radiating efficiently on all hf ham bands must be able to radiate on at least one harmonic and frequently on several harmonics of any particular operating frequency below the 10 meter band.

Thus, when maximum control of harmonics is required, the transmitter must be designed to minimize them in the first place, then constructed with complete shielding and bypassing, operated with proper bias and drive to keep harmonics low, and connected to a single-band filter. Few ham stations require this extreme degree of control—but it *can* be achieved.

How Does the Antenna Circuit Affect the Final Stage? We all know that in any transmitter the antenna circuit plays a large part in the operation of the final rf amplifier stage. Any troubles or problems in the antenna or feedline usually manifest themselves in the form of problems in the transmitter as well. What we're setting out to discover here is *how* this interaction between antenna and final rf stage occurs, and why.

To do so, let's begin by looking not at the final rf stage, but at some earlier stage. It doesn't matter which one, because what we're going to examine is the general working principle of an rf power amplifier.

The purpose of any rf power amplifier is to accept an input signal of some sort, together with dc power from the power supply, and to produce from these two input ingredients an output signal which is a magnified copy of the input signal, identical in all respects except at a greater power level (if the amplifier happens to be modulated, the output won't be identical—but it will depend on the rf and af input signals in that case).

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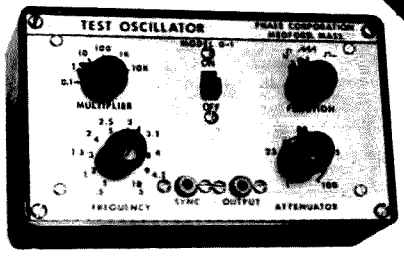
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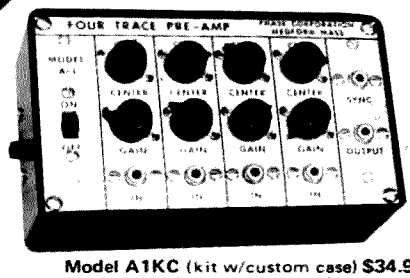
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The input signal comes from some driving source, and the output signal is delivered to some "load." Until the output signal gets to the load, it can't be considered as "output" because it hasn't yet left the amplifying stage.

The normal load for an rf amplifier in the driver stages of a transmitter is still another rf amplifier. To get the signal from one state to the next, the two stages must be coupled together by some means. The normal means uses tuned rf circuits.

These tuned rf circuits also play a part of the role of the "load" for the driving amplifier, so far as the tube itself is concerned. The plate tank circuit has some specific value of impedance, and this value of impedance furnishes the load against which the plate current of the amplifier tube "pushes" to develop the output power.

But tuned rf circuits are rather tricky things; their impedance isn't so easy to define as is that of a simple resistor, because the impedance of a tuned rf circuit involves such things as transformer action between input and output, stray capacitance, self-inductance, and the amount of power taken out of the circuit (which acts, effectively, as resistance inserted into the circuit, and modifies the circuit Q).

For this reason, the *driven* stage influences the operation of the *driving* stage. We say that the two stages are not isolated from each other, or that they interact. We may find, for example, that adjusting the plate tank of one stage may change the plate current of some earlier stage. We are almost certain to discover that a change in the grid tuning of one stage will affect the plate tuning of the previous stage.

This interaction between coupled stages is true of all rf power amplifiers. Some circuits provide less interaction than others (notably the grounded-grid arrangement), but it's always present to some degree.

Now let's go back to the "final" stage. It still must furnish power to a load, but now the load is an antenna circuit rather than being just another amplifier stage.

The interaction, however, is still with us. Any change of impedance in the antenna circuit reflects back into the final tank

circuit of the transmitter, and affects its adjustment. The effects may be minor, or they may be catastrophic—it all depends upon the particular situation.

For any rf power amplifier to operate as designed, the operating conditions intended by its designer must be present. One of these operating conditions is the appropriate value of load impedance.

If the load impedance is too low, or too high, the amplifier won't operate as intended. Too high a load impedance prevents as much of the power getting out of the circuit as was meant to, and may cause severe damage. For example, operating a beam-power stage into an open-circuit load produces extremely large swings of plate voltage in the tank circuit. These swings affect the plate-screen voltages in such a manner as to greatly increase screen current, and it's not uncommon to find the screens of such tubes vaporized by any extended period of zero-load operation.

Too low a load impedance pulls down the Q of the final tank circuit and reduces the effective impedance seen at the plate of the tube. This removes the only limiting factor determining plate current, and again the tube may be destroyed; the main difference is that it's either the plate or the cathode which goes in this case.

These are, of course, extreme examples. But excessive swr on antenna feedlines, caused by improper feedline termination, can approach these conditions. The resulting improper operation can pop coupling or bypass capacitors, cause tuning components to arc over or melt, and burn out tube elements.

The direct means by which the antenna gets into the act at the final amplifier is because it provides the "resistance" into which the final's output power is accounted for. So long as the antenna acts as a pure resistance (or at least acts thay way at the point where the transmitter sees it), the transmitter can be adjusted to deliver its intended output power. If the transmitter is designed to operate into a 50 ohm resistive load and the antenna looks like 50 ohms of resistance, all is well.

If the transmitter expects a 50 ohm load and the antenna looks like 100 ohms of resistance, then only half as much power as expected can be transferred *at the design settings* of the transmitter.

But increasing the coupling between antenna and plate tank circuit, by either changing the number of turns of the position of the coupling link, or changing both inductance and capacitance values if the transmitter uses a pi-network output circuit, can produce the intended impedance transformation and restore normal operation.

If, on the other hand, the antenna appears to be a 25 ohm resistor, then the coupling must be decreased by moving the coupling link farther from the tank coil, using fewer turns on the link, or again changing values in a pi-net.

A more satisfactory solution to either situation is to use an external antenna coupler to transform the antenna's resistance into the 50 ohms of resistance the transmitter expects.

If the antenna does not look like pure resistance, but has either inductance or capacitance as well (it cannot have both L and C, because the larger will cancel out all of the smaller), things get more complicated. The reactance of the antenna will be coupled back into the final tank circuit, because the coupling means between final tank and antenna is essentially a transformer and transformers work both ways. This will detune the final tank to one side or the other of the desired frequency. When the tank is retuned to cancel out the antenna reactance, the coupling may no longer be correct, and when the coupling is changed, more detuning may occur. The net result is, at best, a compromise.

Even if the antenna itself is a pure resistance at the operating frequency, a mismatch between feedline and antenna will produce reactance in the line. The reactance may be either inductive or reactive, depending entirely upon the length of the feedline in terms of wavelength.

If the antenna itself has inductance, or capacitance, at operating frequency, then the feedline cannot match it. Line reactance in this case, though, depends upon the reactance of the antenna as well as upon feedline length and cannot easily be predicted.

No matter how much reactance is present in a feedline, it will look like a pure resistance at a series of points 1/4 wavelength apart along its length. If the antenna is a pure resistance but mismatched in resistance value to the line, these points will be every 1/4 wavelength back from the antenna. If the antenna has reactance, then the location of the first point cannot easily be predicted—but once it is found, the resistive points will recur every 1/4 wavelength back toward the transmitter.

The resistance at these points, in either case, may be very high or very low. It will never be equal to the line's rated impedance unless the line is matched to the antenna—and in this case every point along the line will show that same resistance.

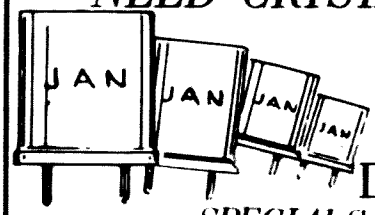
For instance, a 50 ohm line connected to a 100 ohm antenna will have a vswr or 2 to 1. One quarter wavelength back from the antenna, the resistance will be 25 ohms. Another quarter-wave back, the 100 ohm antenna resistance will repeat. From there on back to the transmitter, the 25 ohm and 100 ohm values will alternate. The rule is simple in such a case; at the antenna, the antenna resistance occurs. This defines vswr as Ant/Line or Line/Ant, whichever provides a result greater than 1. Let's assume that the antenna resistance is greater than that of the line, so we use Ant/Line.

A quarter wave back, the resistance equals line resistance divided by vswr. A half wave back (two quarter waves), the resistance is that of the line multiplied by vswr. Thus at odd multiples of 1/4 wavelength, the effective resistance is that of the line divided by vswr, and at even multiples (or half-wave multiples), it is that of the line multiplier by vswr.

The same rule applies even if the antenna is reactive. The resistive points will be either at line resistance divided by vswr, or line resistance multiplied by vswr, depending upon their distance from the first resistive point and its relation to the line resistance. **Fig. 10** illustrates this rule.

Now let's consider a 50 ohm line with a 10-to-1 vswr. The pure-resistive points will be either 5 or 500 ohms. Both these values approach the extremes of short-circuit or zero-load conditions, if they appear at the

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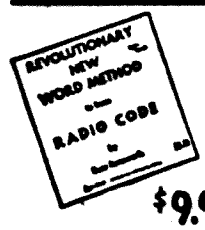
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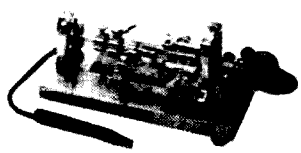
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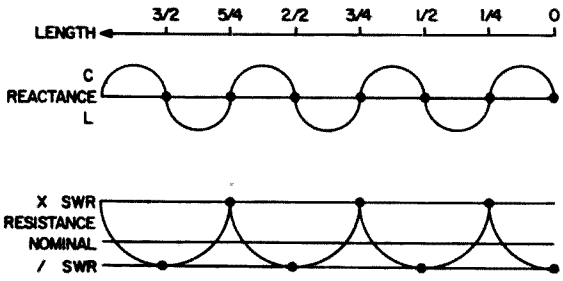


Fig. 10. Relation of feedline impedance to length of feedline.

antenna connector of our transmitter. Component damage is most likely.

In practice, we normally avoid such extremes by "pruning" the feedline so that its resistive component is somewhere near that for which the transmitter is designed, and then accepting the detuning effect of the accompanying reactance. This often works well. Again, an antenna tuner or coupler is better practice, because no detuning results.

In some cases, and with some final-amplifier output circuits, even a very small value of swr is adequate to upset circuit operation. Most affected by swr, surprisingly enough, is the popular pi-network output circuit.

The pi-network is billed as being capable of matching feedlines from 10 to 600 ohms when designed for 50 ohm operation, and this is true enough if the feedlines are resistive. However, the pi-network is a rather complex device which acts by transforming impedances, and one of its critical parameters is the capacitance present in the output side of the circuit. This parameter, in fact, establishes the value of the impedance transformation, which allows it to be used as a "loading control."

If the feedline contains reactance, the reactance may be either inductive or capacitive. If the reactance is inductive, it will cancel out a part of the output-capacitor's capacitance, and thus increase the loading. Such a feedline appears to load quite readily on a pi-net rig, and if the effect is not too severe this may be no disadvantage at all. However, a little too much inductance here may make it impossible to get loading *down* to design value.

If, on the other hand, the feedline reactance is capacitive, it will add to that of the output capacitor and thus reduce the loading. In this case, it may not be possible to make the antenna accept the full power output of the transmitter.

The cure in either case is simple; remove the reactance from the feedline. This can be done either by pruning to some different length (while this may not remove the reactance, it will certainly change it and the change may help), or by using an antenna tuner.

Now that we've seen how the antenna circuit can interact to change the operation of the transmitter's final stage, let's look again at that final stage operation. The stage was designed by someone, originally, who had some definite operating conditions in mind for it. Even if you designed it by taking a published circuit and varying things here and there to fit the content of the junk box, whoever did the original design behind the published circuit had definite operating conditions intended.

Some of these operating conditions include grid bias, grid current, driving power, plate voltage, plate current, screen voltage, screen current, and output power.

Because of the interaction of the antenna, especially in its effects upon output power, plate current, and screen conditions, almost all designs include provisions for varying the coupling between final stage and antenna. These range from a simple variable link which may be adjusted to be near the final coil (maximum coupling) or far away (minimum coupling), through the combination of a link and tuning capacitor (in this case the capacitor often serves as a coupling control and the link position is fixed), to the more complex pi network which may have one, two, or three adjustments. The coupling is intended to be adjusted as a part of the operating procedure, to provide the proper load for the final amplifier tube.

This leads immediately to the question "How do we know when coupling is correct?", but the answer is simple—correct coupling produces the design levels of input and output voltages and current, with the design level of input power and the rated output power. In other words, whenever everything else is right, you know the

coupling is right also—and if the coupling's wrong, something else will be wrong to show you.

What Happens in a Modulated Amplifier? In our previous installment, we examined the goings-on inside a modulated amplifier in considerable detail. We did not, however, delve very deeply into what happens in case various power supplies were to be suddenly short-circuited.

In some cases, of course, shorting of a power supply would simply lead to rather spectacular fireworks (particularly if the plate supply of a full kilowatt rig were to be shorted out, and to a lesser degree with the plate supply for any other device, or any screen supply).

In others, though, and especially if the power supply were intended to provide voltage rather than power, the effect upon the power supply itself might be negligible. The question then would become what would happen to the amplifier, and how would the short affect its operation.

The particular case we're studying is, of course, that cited in the FCC study list—shorting out the grid bias supply of a Class C modulated amplifier. The principles, however, apply to all supplies in which similar conditions prevail.

As we saw last time around, the bias requirements for a modulated Class C amplifier vary from moment to moment during the modulation cycle. Since the requirements are changing so rapidly, it's not possible to manually adjust the bias voltage for optimum conditions at each instant. The way around this problem is to make the bias self-adjusting, by using grid-leak bias to provide a major part of the operating bias voltage.

But when this is done, the fixed bias supply assumes a subsidiary role. Its major purpose, now, is merely to provide protection for the amplifier circuit in case the drive should be removed and so take away the grid-leak bias voltage.

When such a combination of fixed "protective" bias and grid-leak-derived "operating" bias is involved, the effect of shorting out the fixed bias supply will depend entirely upon the ratio between fixed and grid-leak bias. If the fixed bias is a small

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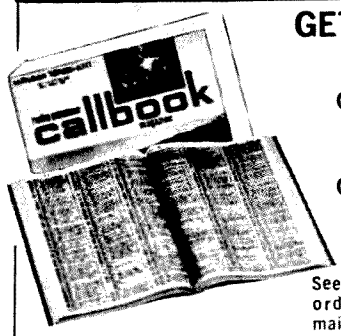
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portion of the total operating grid voltage, loss of the fixed bias supply would have almost no effect upon the circuit's operation so long as drive was available to the stage. The only way, in fact, that its loss could be noted would be to remove drive and watch plate current skyrocket out of bounds.

If, on the other hand, the fixed bias provides an appreciable portion of the total operating grid voltage, with only enough extra bias derived from the grid leak to provide a measure of self-adjustment, then loss of the fixed bias supply would quite probably totally upset the amplifier's operating conditions and might even move its operation from Class C down to the Class B region. This would result in horribly distorted output, due to the drastic change in amplifier operating conditions.

Damage to the bias supply itself caused by a sudden short would depend upon the amount of current limiting designed into the supply. Most rectifiers will stand a very small momentary overload; to prevent long-term overloads, current-limiting resistors are generally connected in series with them. In supplies intended to deliver large amounts of power, these limiting resistors are small. In supplies delivering voltage but little power, the resistors are often much larger, specifically to protect against accidental shorting of the output.

The actual lack of necessity for fixed bias at all on a modulated Class C amplifier is demonstrated by the number of amplifier designs which completely omit fixed bias from all stages. Operating bias is obtained entirely from grid-leak resistors, and circuit protection is provided (if at all) by "clamp tubes" which act to drag screen voltage down to safe values if drive is lost and grid bias disappears. In an amplifier of this design, the whole question concerning bias-supply short-circuits becomes rather meaningless.

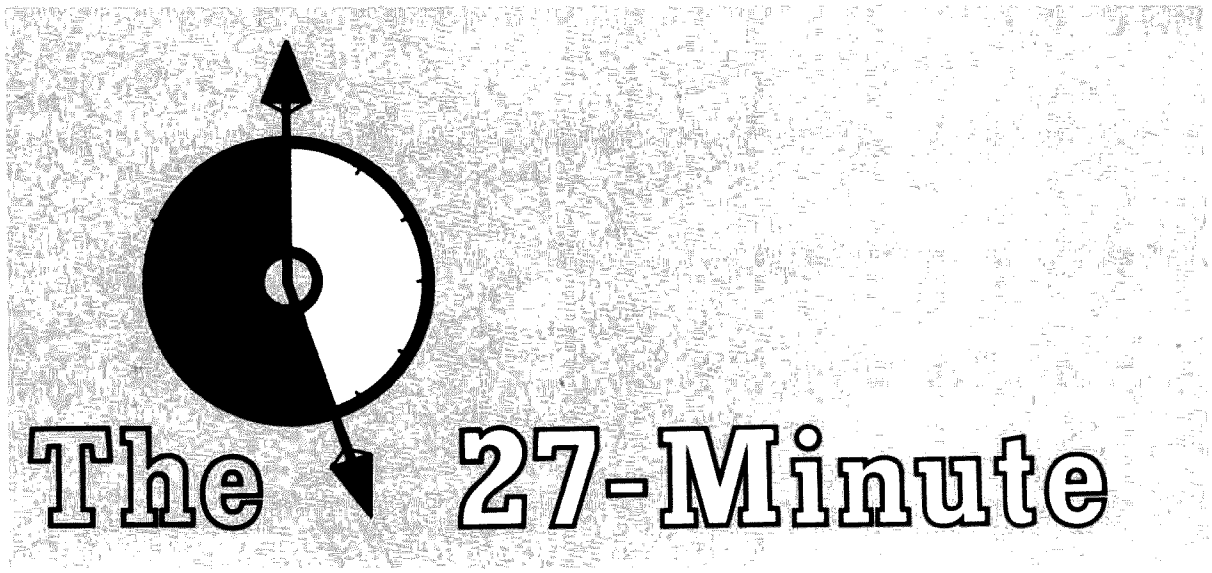
In a broader sense, though, the question still applies even if no fixed bias supply is present. Failure of the grid-leak resistor, or loss of drive, for example, can cause the operating bias to be sharply reduced or even to disappear.

When this happens, the effect upon circuit operation is catastrophic. If drive is lost, then no output can be expected and the entire transmitter is dead. If the resistor fails completely, the same situation occurs. If the resistor suddenly changes value, the transmitter may continue to operate but the operating conditions in the output stage have been completely changed and the chances of satisfactory operation are small.

The effects upon circuit components in such a case are at least as catastrophic. In a Class C amplifier, grid bias is normally the only factor limiting current in either the plate or the screen circuits. When bias disappears, both plate and screen current shoot skyward. Unless extremely rapid-action fuses are included in the circuit (and sometimes even then) the least you can expect is damage to the plate and screen milliammeters, ranging from bent needles to total burnout. If the overcurrent is allowed to persist for any appreciable period of time, and if fuses or meter burnout does not interrupt current flow, the tube itself will be damaged or destroyed. Along the way, any resistors, rf chokes, or coils in the path of the excessive current are also subject to damage.

In the absence of either fixed protective bias or clamp tubes, one scheme remains available to help protect things in case of bias loss. This is to provide a small amount of fixed bias by means of a cathode resistor. While cathode biassing is conventional practice in audio circuits, it is seldom employed in rf amplifiers for one major reason—in order for an rf power amplifier to operate properly, the cathode must be at ground potential. With a cathode bias resistor, feedback between grid and plate circuits is inevitable unless extremely effective bypassing is present. And as it happens, it's almost impossible to get bypass capacitors effective enough to work with cathode bias, since the bias resistance is relatively small and a bypass, to be effective, should have less than 1/10 and preferably less than 1/100 the impedance of the element being bypassed. Rather than attempt to develop capacitors with impedances below 0.1 ohm, most designers simply avoid cathode resistance in rf power circuits.

. . . Staff



Even with the large choice of SSB gear on the market today, there are still many amateurs who enjoy transmitting and receiving a well modulated AM carrier. This is especially true in the field of mobile radio.

A quick check of 10 meters will show that AM QSOs are available in number, and that most are from mobiles running low power. If you haven't done so lately, listen in around 29 MHz, and then sit back and recall when you used to be in there with the best of them.

For the ham who enjoys "rolling his own," AM mobile is a natural. It's even more so nowadays, what with printed circuits and ICs, because they can reduce the size of the gear. Each of us has his favorite transmitter and converter circuits, and the old reliables for antenna switching and control circuits. However, the one area that usually gets short-changed, or simply avoided, is noise limiting.

When you scan through today's ham journals, you quickly discover that the basic methods for noise suppression haven't changed too much over the years. Limiters for converters work well in general, if you're willing to pay the price of modifying the car BC set. This usually involves tearing out the detector stage, rewiring it, and then somehow stuffing the added parts into the BC set wherever you can find the space.

Just about the time I had almost given up on the idea of 10 meter mobile, because I'd have to install a series limiter, I ran across an *old* copy of Editors and Engineers Handbook. In it was a circuit that looked like it would do the job, be inexpensive to build, and above all, would be easy to install. Oldtimers will recognize the diagram as the Bishop noise limiter.

Being a shunt-type limiter, it simply hangs across the last i-f stage in the BC set. It's self-biased and automatically adjusts to the degree of modulation. The bias-circuit time constant is determined by C1 and the shunt resistance, which consists of R1 and R2 in series. The plate resistance of the last i-f tube and the capacity of C1 determine the charging rate of the limiter. It can be disabled by opening S1, which allows the bias to rise to the value of the i-f signal.

So much for the little theory involved, because as we all know, the big question is how well is it going to operate under individual circumstances? In my installation, a tube-type converter is used ahead of the car radio. With the limiter in the circuit, and engine speed at about 25 miles an hour, the noise limiting was better than I expected.

However, when the cruising speeds of 60 or 70 mph were reached, the limiter was "swamped out." It couldn't handle the incoming pulses fast enough. As you've probably guessed, the problem was quickly cured by changing the R/C time factor. This is indicated by R_X, where I paralleled two more 270 kΩ resistors. These values, of course, were needed in my limiter, and

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Mobile Limiter

the resistance will probably differ for yours. With that minor change, the limiter works as effectively at 70 mph as it does while waiting at a traffic light.

As for the title of this article, it took about 27 minutes to install and wire the parts for the limiter. I've never been able to install a series limiter in that small amount of time. The author would like to thank Bob, K7JSD, for his help during the "cuss and solder" stage of work. Bob is known locally for the crafty way in which he sweat-solders 7-pin sockets!

Parts installation couldn't be much easier. I punched a hole in the rear lip of the BC set for the 12AL5, so that the tube could be installed after the set is back in the dash. Inside the receiver is a four-lug tie strip, on which the few parts are mounted. If you buy everything new, it'll cost about $3, including the 12AL5.

Semiconductor diodes of the computer family were seriously considered at first, and we thought about using 1N658s. However, they are more expensive, and I have a strong respect for the back resistance of the 12AL5 for this kind of application.

There are many "peanut whistle" rigs on the high end of 10 meters nowadays, and it has been a pleasant experience to rediscover the fun of AM mobile. The limiter I've described will really help pull those other mobiles out of the noise level. You may even find that after you've finished reinstalling that old mobile AM gear, you can kick the sideband habit!

. . . W7SOH ■

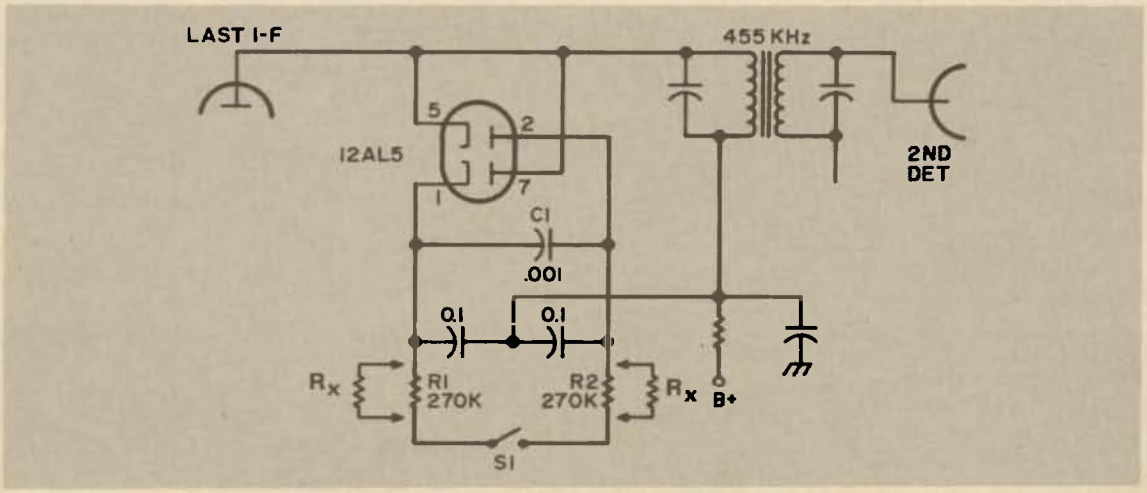


Fig. 1. Bishop i-f noise limiter.

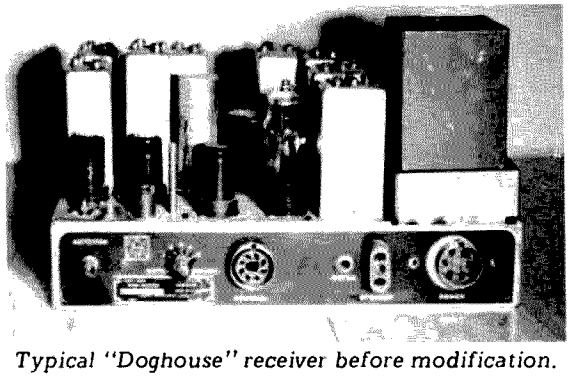

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Typical "Doghouse" receiver before modification.

Fortunately, for those short of money, a good receiver can be had for a few bucks and a little work – at least for the 30–50 MHz band. "Doghouse" type receivers covering this band are still found in surplus stores for around $15. These receivers are all quite similar, having been built by Motorola, or to Motorola prints by various subcontractors. These sets use 13 octal tubes. Typical model numbers are R-237/B-VR, P-8028, and FMR-13. They all have a first i-f of 4.3 MHz and a second i-f of 455 kHz. They are wideband (±15 kHz), single-channel, crystal-controlled units and nominally cover 30–40 or 40–50 MHz. Typically the front ends use 6SD7s or 6SG7s for oscillator, first mixer, and rf amplifier.

The conversion consists of building an ac power supply, connecting the local controls, and converting the crystal oscillator to a tunable type. Depending on the frequency to be monitored, the rf and mixer coils may require pruning.

First, remove the vibrator power supply by taking out the three large screws holding it to the chassis, disconnecting the red and yellow plugs, and lifting the supply off. The power supply shown in Fig. 1 is then built

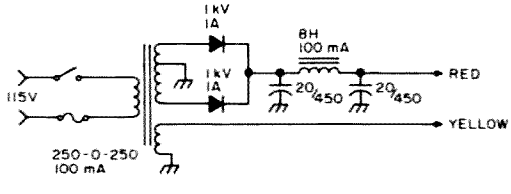


Fig. 1. Power Supply

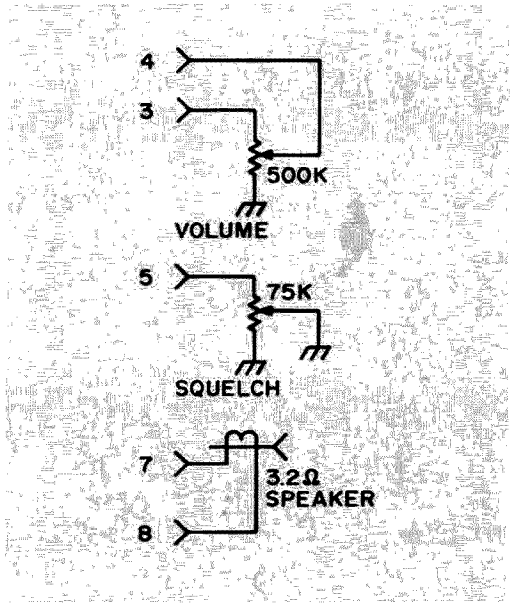


Fig. 2. Control Connections

on the chassis in the space vacated by the vibrator power supply.

The controls shown in Fig. 2 are then wired in. At this point it is advisable to "smoke-test" the set. Turn it on and check to see that the squelch and volume controls are operating properly. If you have a signal generator, feed a 4.3 MHz signal into pin 4 of the first i-f to see if all the low-frequency stages are operating properly. Frequently the conversion crystal is missing. If so, the replacement crystal frequency is 4755 kHz.

Figure 3 shows the before and after modifications made to the oscillator. At this point, a word is in order about frequency allocations. Most areas seem to group the local frequencies quite close together. In Orange County, California, for instance, most of the channels of interest lie between 45.1 and 45.7 MHz.

The front end of this set is good and broad, so rf tuning is not needed. In operation, the slug of the oscillator coil is positioned so that the tuning range of the oscillator is centered in the band of interest. A station in the center of the band is tuned in and the trimmers of L2 and T2 are peaked for best reception. Since all police transmissions are now narrowband, some improvement can be made by clipping the loading resistors from the primaries of T3, T4, and T6. The i-f's are then peaked.

If you have a 30–40 MHz receiver and want to cover the high end of the band, it will be necessary to remove one turn from L2 and T2.

Once you have the receiver working, you are ready for some serious monitoring. A well located antenna is a must. And omnidirectional coverage with vertical polarization is very desirable. A good approach is to buy a CB base station antenna and trim the elements to your frequency of interest.

This brings up the problem of how to find out what frequencies are in use in your local area, and the codes. There are two ways to do this. The first is to visit your local police or sheriff's communication center and ask. If you are too timid, you can invest in a good listening guide. There are a number commonly available.

. . . W6JTT ■

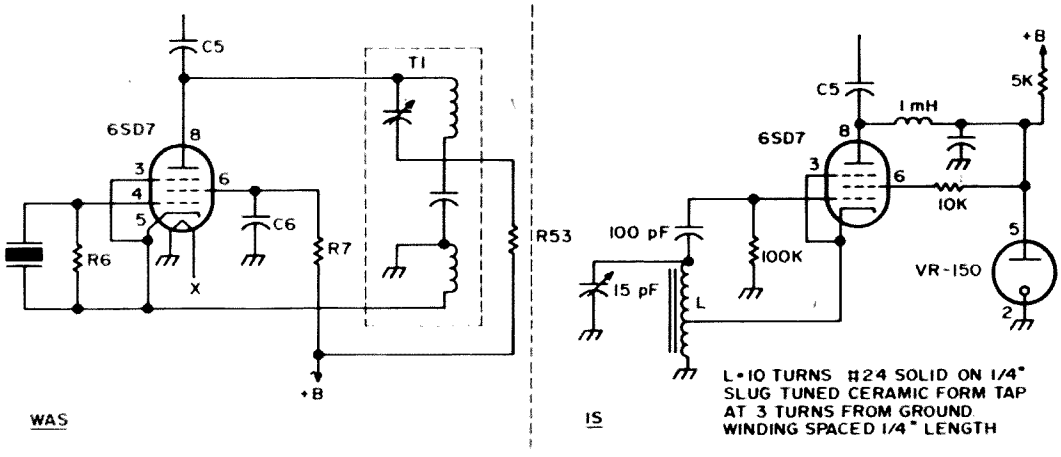
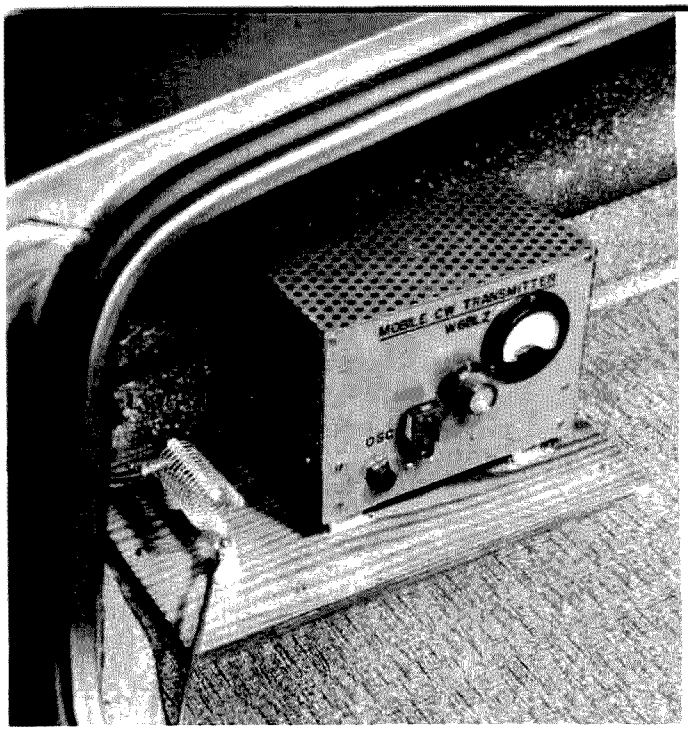
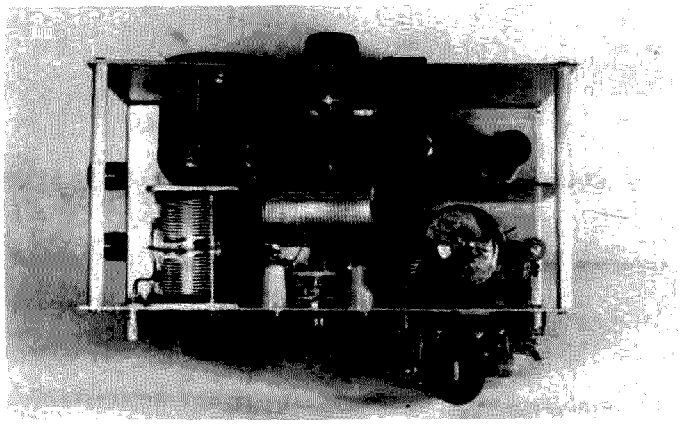


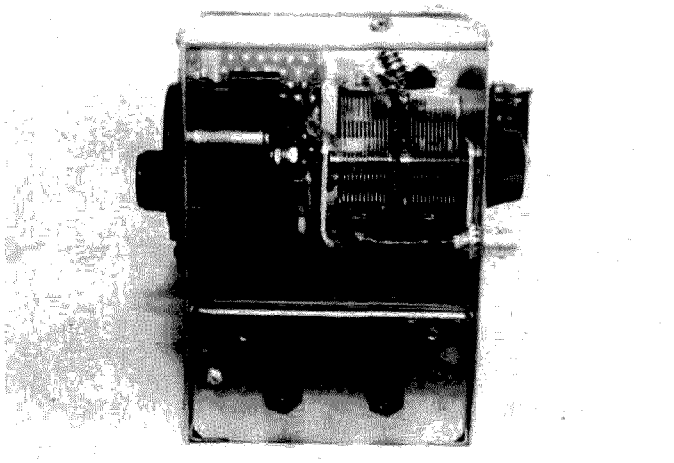
Fig. 3. Oscillator Modifications.



Mobile rig installed in the back of the car and showing antenna coil mounting.



Top view showing the output coil and tuning capacitors.



Side view showing the power supply transistors and General Radio input terminals.

Ed Marriner W6BLZ
528 Colima Street
La Jolla CA 92037

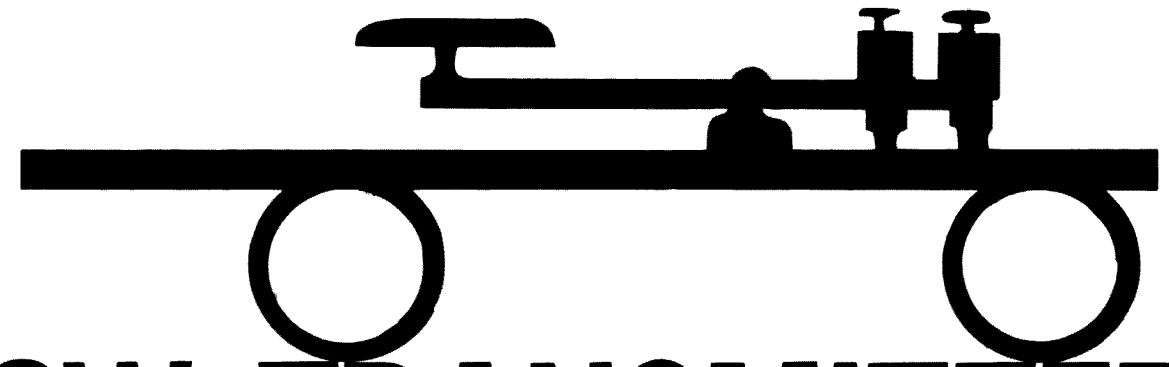
A MOBILE

This is a description of a 50W (output), self-contained, mobile CW transmitter, for the 80-40-20 meter amateur bands. The basic idea for a simple CW rig was to have it available, and installed in the trunk of the car out of the way.

The output power is sufficient to hold regular schedules back to home base, even on long trips when you can shift to the 14 MHz band. For simplicity, plug-in coils were used for the oscillator, and a shorted coil for the output. Changing bands is not as difficult as it may first seem once the rig has been tuned up previously on each band. The cover is slipped off, the switch turned, and the coil exchanged for the other band and the knobs reset to the marked bands. The transmitter power can be turned on from a heavy-duty switch or by using a 12V dc relay from the driver's seat. A key can be mounted in the driver's compartment or strapped to the steering wheel. If a 5–10 kΩ dc relay coil is used, a low voltage battery of 15-22V will actuate it with the key, or you can tie into the car battery.

Theory

The crystal-controlled oscillator is a 12BY7 tube, and the filament heats up in 11 seconds. The oscillator has plenty of output to drive a 12DQ6 on all bands. This tube also heats very rapidly and both are more available and cheaper than quick heater filament type tubes in the 12V variety. The cathodes of both tubes are



CW TRANSMITTER

opened for keying so that the rig could be turned on just before the contacting station signs his call; thus with the tube's cathode open the oscillator does not interfere. A 100Ω resistor and .01 capacitor across the key acts as a filter.

To operate the set on 20 meters, a 7 MHz crystal is inserted in the oscillator and the plate circuit tuned to 20m works as a doubler. Normal operation on 40m would be to use a 7 MHz crystal, or you could use a 3.5 MHz crystal with the plate tuned to 40m. Both work satisfactorily. If 80m operation is intended, a set of 80m crystals that will double into the 40m CW band will work out fine.

The power supply uses a Triad toroid oscillator transformer which operates in the audio range, making filters very easy; no heavy choke is required. The whole rig and the 400-250V power supply fits on the chassis without crowding.

Construction

The transmitter and power supply are built on a California Chassis A-147, 4 x 8 x 2 in. General Radio terminals are sanded down to make a tight fit on the end of the chassis to receive the 12V from the car battery. Once these terminals are in place, the power supply parts can be fitted under the chassis and wired before building the rest of the rig.

It is best to get the power supply working before proceeding with the rest of the wiring. All parts were mounted using lock washers and then dabbed with Glyptal varnish to keep the nuts and bolts from vibrating on bumpy roads. The rig was also mounted on load mounts to help absorb some of the shock since this rig was intended to stay mounted in the car.

The oscillator plug-in coil forms were snagged from a plastic sack hanging in the radio store listed as "Calectrocorp, low-loss plastic coil forms, Cat. 1-899P." The sack with a socket and coil form was listed as 1-898-A. It took 30 turns of 28 AWG enamel for the 80m coil, 19 turns for 40m and 9 turns for 20m. The coils are terrific, they plug in and out easily, and the base will unscrew to make wiring into the prongs easier. The pi-network coil was 16 turns per inch, 1¼ in. diameter No. 1416 Air-Dux bulk coil. If your local parts store doesn't have it, it can be obtained from Western Radio, India St., San Diego, California.

Tuning

In most instances, neutralizing was not found necessary with the 12DQ6 tube; however, the circuitry was included. A wire was soldered to the bottom of the oscillator coil and the junction of the 270 pF capacitor to a feedthrough insulator. On the top side, 4 in. of 18-gage wire was soldered vertically alongside the tube. To neutralize, turn on the oscillator and remove both the plate and screen voltage

from the 12DQ6 by unsoldering the wires. Pick up the feedthrough voltage in the plate tank circuit with a grid-dipper in diode position. Now push the vertical neutralizing wire back or cut off in small nips until the feedthrough voltage reaches the minimum possible. The tank should be connected to a 50Ω noninductive resistor and peaked for 40m during this procedure by using the grid-dipper as an indicator.

Generally the best way to adjust the transmitter is to first feed it into a dummy load made up from noninductive resistors. Once tuned to this 50Ω output, the transmitter knobs are left almost untouched, and the output coax run to the coil. The braid is fastened to ground at the same place the coil is grounded and the tap moved back and forth, adjusting for maximum radiation. Closing the trunk door will have some effect on the antenna adjustment, and if possible tune with the door closed.

Battery Cable

A long length of 12-gage rubber-covered wire was used to go from the trunk to the battery. I drilled a hole in the trunk and fastened the wire with plastic clamps on the body frame to a terminal strip in the engine compartment. A 12V relay was used to operate from a toggle mounted on the dashboard for turning on the power; however, if you can run the wire inside the car, a good heavy duty 15A switch will suffice.

... W6BLZ ■

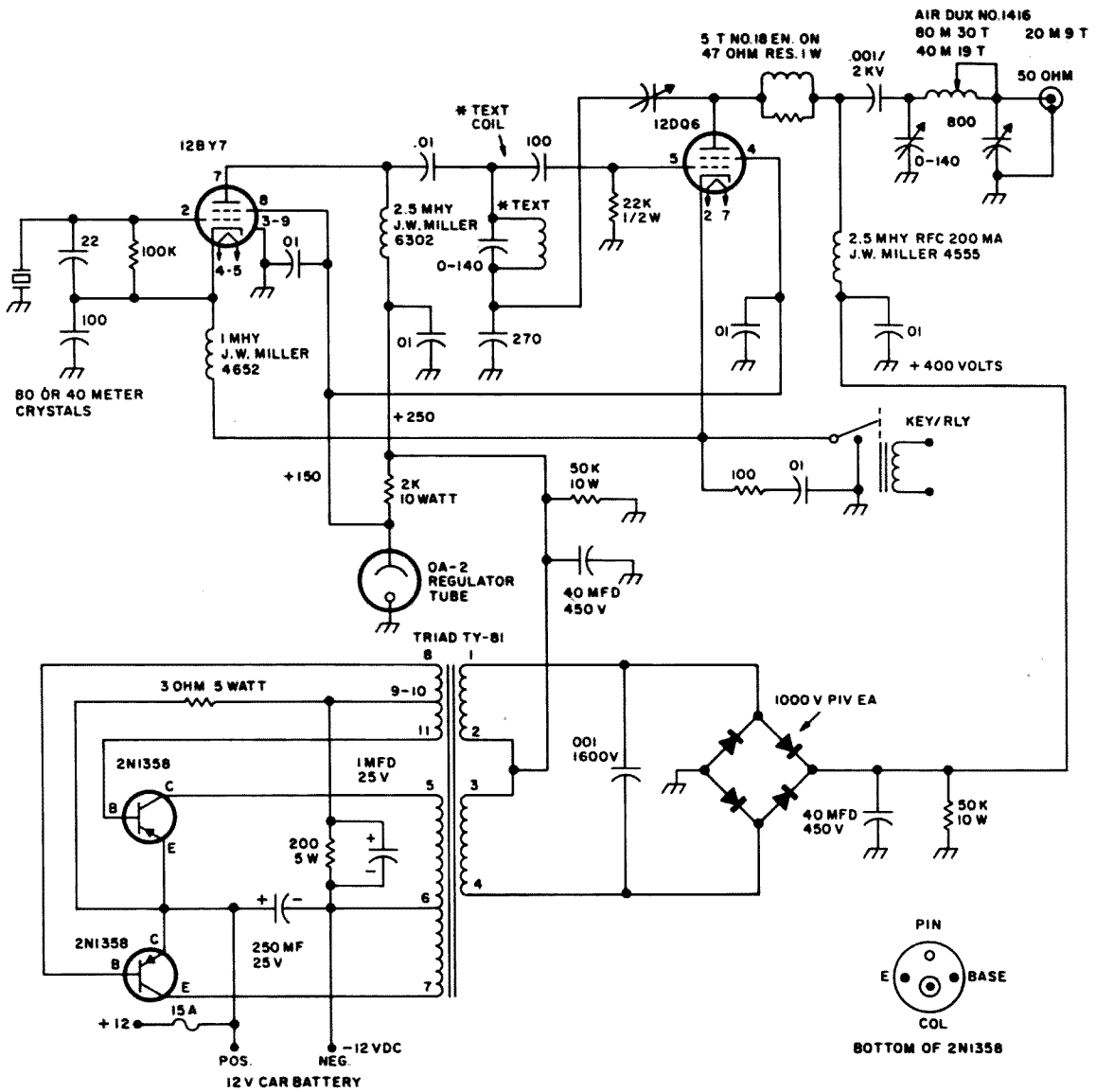


Fig. 1. Schematic.

(continued from page 13)

business mail like this. Little of this really has to be done on paper or to be physically sent in an envelope.

Picture a small typewriter with a built-in tape recorder. IBM has just such an item that we use for typesetting, so there is nothing basic left to be invented, just compromises to be made for mass production and cost-cutting. For not a lot more than the regular phone service a unit such as this could be rented and connected to the phone lines. All businesses have phones, and all but a few homes have them, so a service using this existing facility would get just about everywhere.

Your tape-typer would correct mistakes merely by back spacing and retyping over. Instead of paper it could print out on a small television screen. When the message is completed it could be addressed to a phone number and, with the push of a button, sent on its way. You want a copy? Another button would put it on a permanent tape for your file, coded for fast retrieval.

The phone would not be tied up with this system since it could operate while the phone is being used normally.

The phone lines are already all in, so all that would be needed for this system would be the tape-typers and the automatic routing equipment in the phone company exchanges.

The cost per message should be a fraction of the present cost of sending letters. And think of the saving in paper, stamps, typewriters, ribbons, and shoe leather for the postmen. Even at that, the mailmen won't be out of business by any means, for they will still have to struggle through the sleet and hail to bring you magazines and ads for Florida property.

Incoming messages would be taped and could be read at your leisure. Permanent copies can be made of important messages on tape cassettes.

If we can reduce the mail load by 80% perhaps they will be able to get the magazines through in better time? And wouldn't it be nice to be able to send letters again for 2¢ and have them delivered within seconds of being sent? That would be better than the old two deliveries a day we used to have a few years back.

73,
. . . W2NSD ■



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A little FM unit that should be available in two surplus markets – commercial & military . . .

An FM "Best Buy"

Now that you have read all the fine articles in 73 Magazine about the fun of FM, let's talk a bit about the kind of mobile gear you are going to get. This surely deserves a lot of talk, for there are some surprises in store for the unwary.

You hear about a fine piece of gear made by Motorola or GE, and you take a look – and you generally see a monstrous contraption too big to get into the seat or the trunk of a small car – with enough tubes in it to stock an electronics distributor for life – and a circuit so complicated that some of us have been known to faint dead away at the idea of even taking off the cover! Maybe you like vast puzzles – but some of us don't.

So you try for a little one: a "handie talkie" sounds like a great idea – and in some ways it is. Take one of the older low-priced models: Has just a little power – has a headset like a telephone that gets very tiring to hang on to – has a small number of tubes, but they are in some cases so old and rare that you will have better luck searching for spares in the Egyptian pyramids than in your electronics catalog. And if you want to go ac powered you have some rare and refreshing problems in rigging up a power supply to handle your antique curiosity.

There are some modern, compact FM transceivers, and I won't knock them at all – they do a real great job – particularly when you realize that with a repeater you only need about one watt output to have a tremendous signal on the band.

But if you are like me and don't have a lot of spare cash lying around, then you will want to look at something a little lower priced. So, how would you like to get a small, compact transceiver – with power up to 50W out; that is neat, dependable, reliable – that's proved itself throughout the world for maybe 25 years, that's used in all types of state and federal aircraft and at airports, that is a proved performer in Coast Guard service, that did a bang-up job at the South Pole in Operation Deepfreeze, and that in rugged service in Alaska stood up

better than far more complex and sophisticated units? How would you like a transceiver that is old and moderately priced, but with tubes that you can still find in the 1970 Allied cataiog? And how about a unit with absolutely no trick circuits, with plain, conservative, simple design and layout for easy maintenance, a unit so simple in fact that this old horseracing writer can, with his feeble knowledge of electronics, partially understand the thing in at least a dim and groping way?

We are talking about the equipment made by Combo, in Coral Gables, Florida. And we are talking about their old tube-type equipment. (They, of course, now put out a modern line of solid state gear at the usual industrial price levels, but we are not talking about that!) My own set is an old Model 275, which was made some time before 1950. I paid the huge sum of $10 for it. It still puts out a tremendous signal – 10W out (in commercial practice they use watts *out* to measure power – 10W out is equal to maybe 20W *input*).

No, I don't own any stock in Comco. Nor do I have any of their gear to sell. (Fact is, my only contact was when I wrote for information on the Model 275 – I got a prompt answer, but no information!)

We will talk mostly about the Model 582. This is a good rig, and represents the kind of equipment they made in the past. There are lots and lots of other units they make that are suitable for amateur service – I have listed them in B, Table I. There is my Model 275, with a single channel, a 6V mobile unit. It's a handy 2 meter rig. Model 580 is good for the 6 meter band – it can have all kinds of power supplies and may have one or two channels, and an output of 25–50W. Model 680 is for the 6 meter band, and can run 1 to 4 channels with up to 100W out. A lot of power there. Model 906 is a somewhat advanced piece of gear that would also be very fine on the 6 meter band.

For the 2 meter band, we have Model 582, which gives you one to two channels, and 18–25W out. Model 682, another fine 2 meter rig, will get you up to four channels and 75W out. Model 800 is a sophisticated hand-held transceiver of the modern generation, and Model 900 is a modern transistorized portable rig – both are great on 2 meters. Also for 2 meters there is quite a range of military equipment (Table II). These have a bewildering variety of power supplies to meet military needs! The AN/FRC-70 and 70A run 50W on 2 meters, the AN/VRC Models 42, 51, 51X, and 52 run 25W on 2 meters. These are dandy rigs, and require no appreciable retuning for use at 144–148 MHz. The AN/VRC-58 is another excellent 2 meter rig.

Some of the military rigs will hit 10 meters with little trouble. The AN/FRC Models 52, 52A, and 52B will give 50-60W out. The AN/VRC 33 and 33A are single-channel mobile units (at 35W out) and won fame in Project Deepfreeze. And, for 10 meters, the AN/VRC-60 works great with a 12V power supply and gives out a good 25W.

Or maybe you would like to try the popular amateur UHF region (called 450 by FM'ers). Try Model 684 shown in Table I; you get 10 to 25W out in the 450 MHz range with no tuning problems.

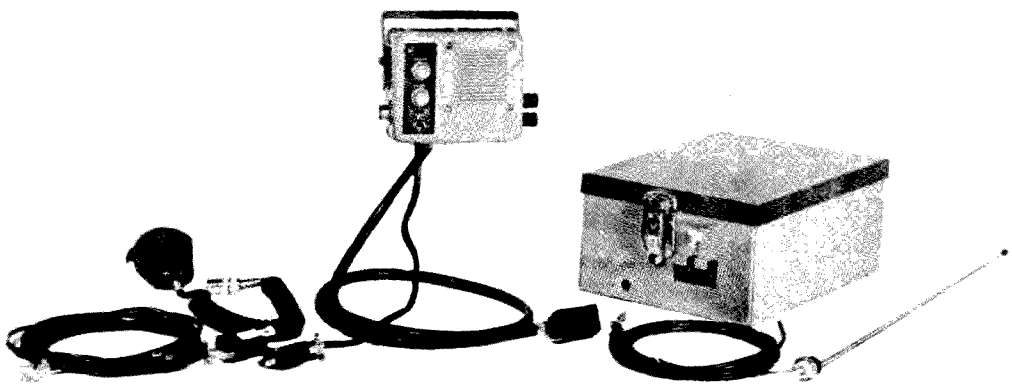


Fig. 1. The Model 582 for mobile mounting.

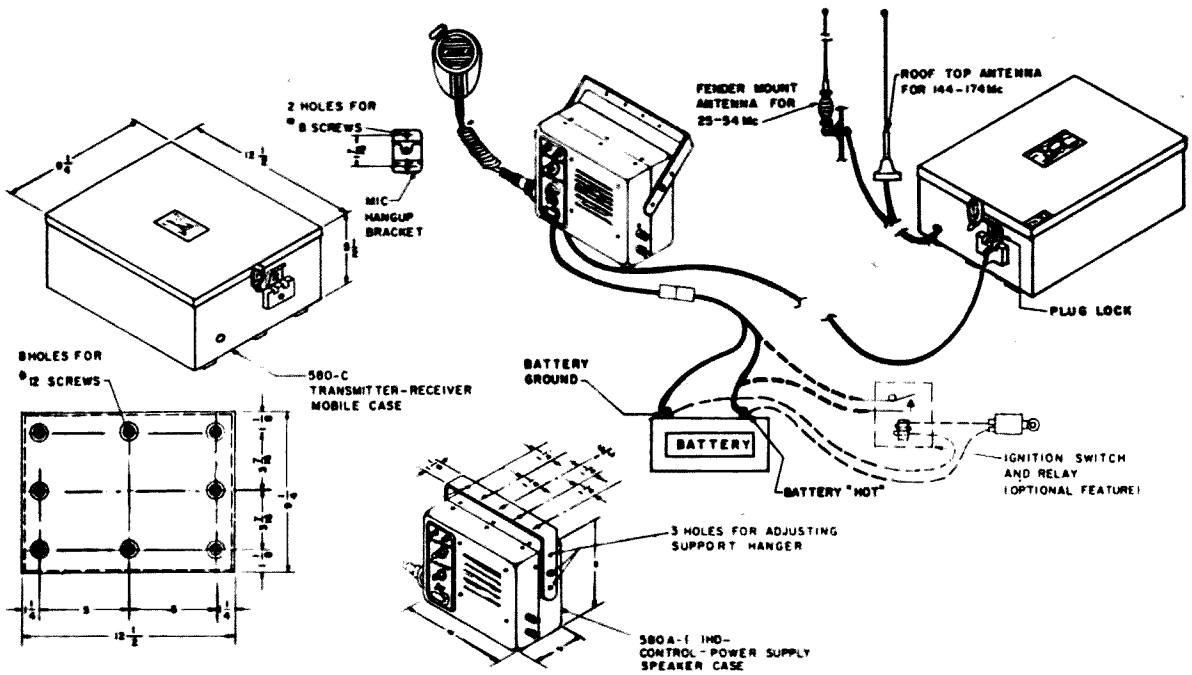


Fig. 2. Mobile hookup for the Model 582.

Let's look at some pictures. Figure 1 shows the 582 set up for mobile mounting. The little case, about the size of three reams of typewriter paper, will fit anyplace. The control head, speaker, and mike go under the dash. Figure 2 shows the mobile setup.

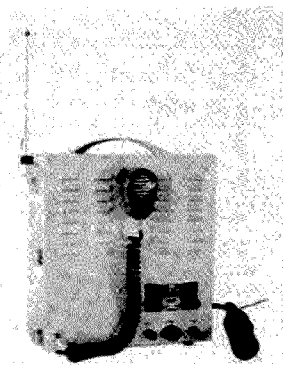


Fig. 3. Model 580/582 hand-held portable rig with an output up to 50W.

Figure 3 shows the 582 made up in a battery powered hand-held rig. This is no toy transceiver – it's got a good speaker and good mike – and a solid 50W output! It has an ac/dc power supply, is just about the handiest rig you could get hold of.

Now let's talk about the base setups. On some of those big, black rigs we mentioned earlier, you will use up half a room to store it and get some unhappy looks from the XYL if you even think of bringing it upstairs. Or, with some of the beatup, cobweb-covered battle-scarred veterans of other wars you find in surplus stores, it is best to dig a hole and give the whole thing a burial rather than to clutter up the living room or study with it.

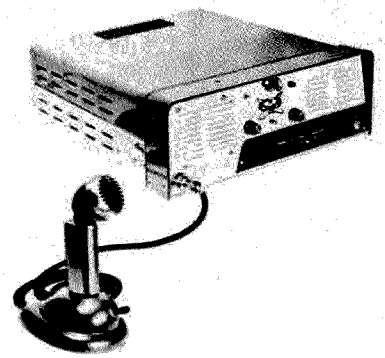


Fig. 4. The Model 582 makes an elegant base station.

But we don't have these troubles with the 582. Figure 4 shows how it makes an elegant base station, suitable for just about any room in the house.

Now, let's sort of flit through the block diagram in Fig. 5. The transmitter section multiplies 16 times for 144 MHz output and will take crystals in the 9 MHz range. Starting at the front, we have the oscillator feeding into the "phase modulator" tube. Don't let that term "phase modulator" scare

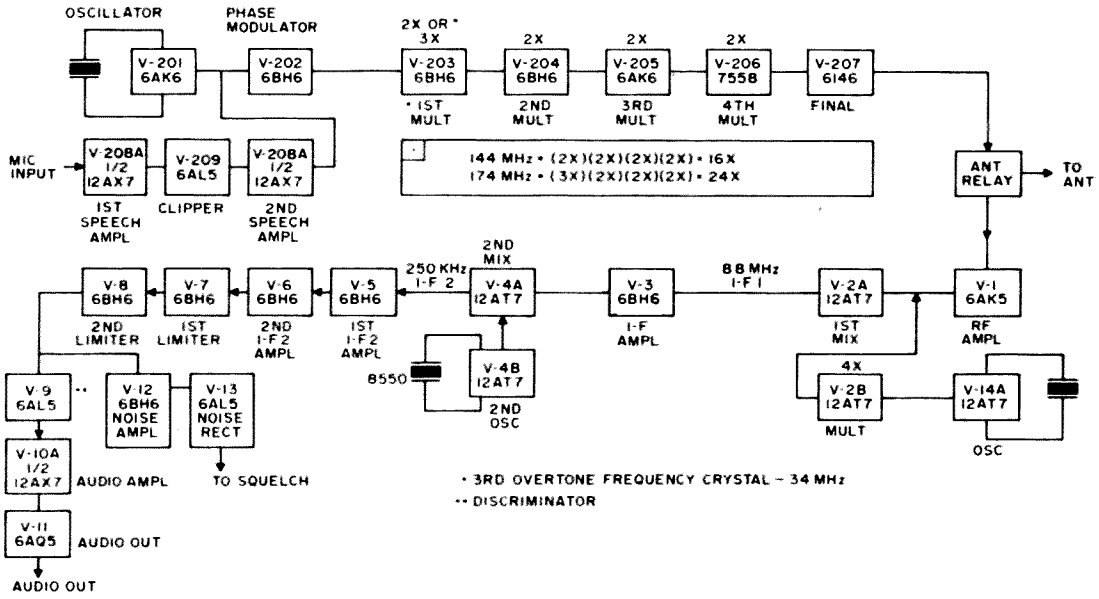


Fig. 5. Block diagram, typical 144–174 mc transmitter-receiver, 582 type.

you. All it means is that we are modulating *after* the oscillator, instead of at the oscillator. This allows a wider flexibility in control of "deviation" (Modulation) and is otherwise undetectable from frequency modulation per se.

How the thing works is not important – and I don't believe half the stuff I read about how the electrons gallop around anyhow – but it *is* important to know that any variation on the plate voltage of the modulator tube will modulate the signal, whether you want it modulated or not! So keep a sharp lookout for loose connections, intermittent shorts in capacitors, and the like.

From then on you multiply out all the way. One big advantage of FM (we call it that, anyway) is that any of the signals getting out–such as the lower harmonics–will be less likely to tear up your neighbor's TV reception. I have a friend who had nothing but neighbor trouble with a flea-power AM outfit, then he switched to a 30W FM outfit and there has been nothing but joy in the neighborhood since. By the way, he has demonstrated that he can take his 2 meter FM gear and trip our local AM repeater, and I can hear him great on my AM "Twoer"–guys with sets not a megahertz wide in front can copy him easily, too.

Now let's see what we can do with the receiver. The stuff comes in at, say, 144 MHz, and there is a stage of rf amplification. Then you have to convert it to the first i-f of 8.8 MHz. That works out to about 34 MHz in the oscillator, multiplies four times to about 136, and there we are. Only there ain't no crystal which we can afford at 34 MHz, so we buy a third overtone crystal and we're in business.

Then we have an 8.8 MHz i-f amplifier and another mixer. We feed the mixer with an 8.550 MHz signal from our crystal oscillator, and here we are at the second i-f of 250 kHz. That makes for nice selectivity. We run that through two amplification stages.

Now we hit two "limiter" stages. The idea here is to remove any AM components (such as noise) from the FM signal. The limiter chops off any high peaks and the whole thing comes out at a constant level.

Now the discriminator looms up before us. This is simply the same kind of a function as the "detector" gives us in an AM set. Next comes an amplifier and squelch circuit, designed to make life easier for the listener.

That's about all there is to it. And it's why I say that the best buy in mobile FM gear is surely the Comco Model 582 or one of its brothers. Many, many thousands of such FM models have been made – you should be able to locate one without too much trouble. Good luck!

. . . WA7EMM ■

SCIENCE FAIRS

SCIENCE EDUCATION?

by Fred Mocking
Science Editor
Radio Today

Every year, many of our grammar schools and high schools participate in "science fair" programs. The purpose of these fairs is to stimulate interest in science and to provide experience in working on science projects. Students who enter the fair do indeed gain worthwhile experience and knowledge. Many of them are fortunate in having guidance and help from parents with technical skills, or help from parents or other adults with access to unusual technical facilities. Although science fair regulations attempt to rule out this type of help, the students do, nevertheless, benefit from it. Indeed, if they were to depend solely on their own resources, many students would be unable to enter projects at all.

In spite of the positive values present in science fair activities, many thoughtful observers have questioned the basic premise that science fairs stimulate interest in science. This may astound those who have visited these fairs and who have seen the truly outstanding accomplishments of our youngsters. Yet the skeptics state that the students who receive the maximum encouragement and assistance are those who have the greatest interest and ability in science and thus who are least in need of help. Without doubt, science fairs help *them*, but what about the rest of the students? Are they better off, worse off, or unaffected by the fair?

Another question that has been raised, and moreover that has been raised by student entrants and by student winners is the fact that the "spectacular, flashy" exhibit wins. Many students believe that this is so and thus deliberately choose a project, not on the basis of their own interest or the intrinsic value of the project, but on its potential ability to impress the judges. As a consequence, we have students who will enter a laser or a Tesla coil exhibit while at the same time having no conception at all of the more elementary principles involved in electrical circuits. Thus, superficiality is encouraged at the expense of a firm understanding of basic principles. Is it not surprising that activities sponsored by educational institu-

tions should drift so far from sound educational principles?

A closer look at the science fair itself will provide some insight into this state of affairs. The primary objective of most students who enter is to win! Those who progress through the local, district, and state fairs may win one of the valuable scholarships offered and, after graduation from college, many are offered jobs by leading technical companies. In other words, the science fair program provides a simple, straightforward technique for "skimming the cream" of the scientifically able students and steering them into the technical fields that are vital to our national progress.

Now, I have no quarrel whatever with people who "skim off the cream" but I cannot accept this as a process that results in "enriching the milk." Our nation has a vital need for people in many fields who have sound backgrounds in science and we cannot afford the luxury of haphazard dependence on the relatively small group whose interests *happen* to lie in the science area.

A number of educators have become dissatisfied with science fairs for this and other reasons and have discontinued science fair activities in their schools. Other educators simply have a vague feeling that something is wrong without being able to identify it more specifically.

If we are to improve this situation, let us accept as a basic premise that *some* of the science fair activities should result in some positive return to the schools involved, that is, some benefit for all the students, and perhaps even for the teachers, who put forth so much effort towards making these fairs successful. This could lead to the following guides for new categories of science fair activities:

1. Science fair activities should, in part, result in equipment that may be used in the schools, and be relevant to the existing science curriculum. (Few teachers would complain that they already have *too much* equipment.)
2. Reduce the emphasis on *original* research by providing for projects based on hardware that simply and effectively demonstrates *known* principles incorporating student "feedback." This area has hardly been touched and in itself offers many opportunities for creative work.
3. Encourage projects that lead to simple experimental equipment that can be duplicated in classroom quantities in the school shops. Thus school laboratories can acquire equipment for each child rather than a single demonstration apparatus for the entire classroom.
4. Eliminate the need for concealing or apologizing for parental aid. If the student can bring to bear unusual resources in technical aid and equipment for the benefit of the school, why rule it out?

Other rules may be suggested, but the four items above are sufficient to show what the potentialities of science fair activities may be, once we choose our objectives properly.

Schools have been criticized for a lack of contact with important new concepts in technology and science. This problem is not the fault of educators, it is the result of a total lack of two-way communication between educators and the scientists and engineers who are familiar with current technology. Item 4, listed above, can be used to provide one framework for such communication by means of projects based on the very technology and devices that the schools would otherwise be unable to obtain. Anyone familiar with modern industry realizes that creation of a sound design takes considerable time and effort, but once such a design is created, it can be readily duplicated and made available for many users. Why should such a basic economic fact of life be excluded from our educational institutions?

Science has given us techniques to achieve almost any technological goal we may care to establish. It is time that we rethink our objectives in science education and write rules that will get us to our goals. To do any less is, to say the least, unscientific. ■

The Wichita Autopatch



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Wichita KS 67217

Tied in with the local repeater, this phone patch received approval from Ma Bell . . .

The purpose of this article is to give a description of the automatic telephone patch system developed for the two Wichita 2 meter repeaters. The features include mobile dial control, giving the mobile radio amateur access to the landline telephone system, as well as making other functions available to him. Many methods of remote control have been developed; most use one or more tones transmitted simultaneously or sequentially, but the method used at Wichita is a modified "Secode" type, or interrupted "single tone."

Secode systems transmit a tone of fixed frequency, interrupting the tone with no-tone pulses, created by the contacts of a standard rotary telephone dial. The decoding units sense the presence of tone and count number of "holes." When the proper sequence of pulses (holes) are received, the decoder unit will make a set of contacts for a short period (momentary "make"). A single decoder unit can be set to select from one to five functions at the remote location. We use separate functions to turn the telephone patch on and off.

The Encoder

The diagrams shown in Figs. 1 and 2 are almost self-explanatory. The output link is wound on the 88 mH toroid, using as many turns as needed. (See Fig. 3.) For high-impedance microphone circuits, 10–15 will be required; for low-impedance microphone circuits, 30 turns should be about right. The dial can be almost any type, but must have a set of open contacts that "make" when the dial is rotated "off-normal." I personally prefer the Stromberg-Carlson dial, which has extra contacts and is indicated in the drawings. To use the more conventional Western Electric or Kellogg dials, the two diodes make a simple

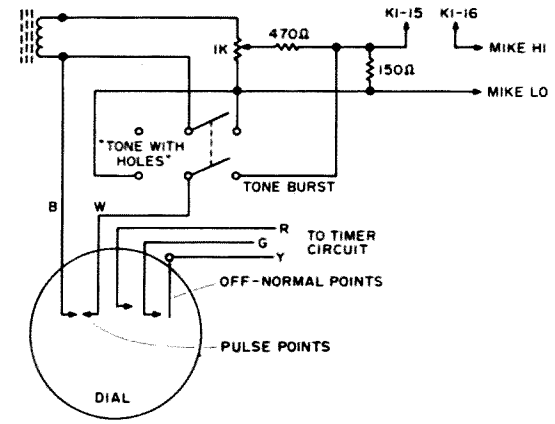


Fig. 1. Schematic showing output portion of dial encoder.

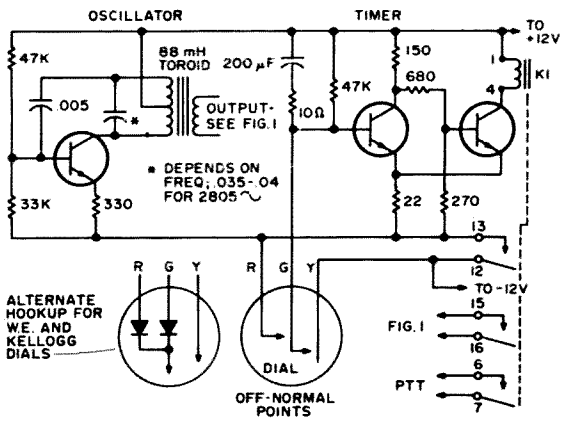


Fig. 2. Schematic showing oscillator and timer portions of tone encoder.

"and" circuit. Note: the dials from "Trimline" telephones are small and pretty, but they do not have the "off-normal" points and cannot be used. The dial pulses *must* have the correct speed and make–break ratio. Checking dial speed and make–break ratio is not difficult; one of the easiest ways is a 15 ips tape recorder with editing facilities. First, make a recording of WWV and the time ticks. At 15 ips the time ticks should be spaced 15 in. apart. This verifies your tape speed. Next, record the output of your tone encoder transmitting the digit "zero." Careful use of a grease pencil or nylon point pen to mark the on and off spaces will show you the speed of the dial and the make–break ratio. In our area, we require 10 pulses per second, and the open or "break" time should be 60%. In other words, ten pulses should take 15 in. and of the 1½ in., the pulse points on the dial should be open about 9/10 in.

Once you have one or more encoders checked out, transmit the tone through the decoder to test the pulsing relay. Adjust spring tensions, air gaps, and residual screws as necessary to obtain the same make–break ratio as transmitted by the encoder. The timer circuit holds the transmitter energized during the "interdigit" time. The 200 μF value is nominal, and can be varied. The relay shown in the diagram is a common item, but not critical. To hold the tone frequency to ±5 Hz, use of Mylar capacitors is recommended.

The Decoder

The equipment used in the channel A repeater (146.34 to 146.94 MHz, WØDKU) is a modified Secode RPD-612 with ac power supply (Fig. 4). At first, we used a single five-function selector, model 49HS-5. We later added a model 70 selector with a five-function kit added. We now have ten functions we can select and know of no reason why more selectors could not be added. An additional stage (Fig. 5) is "tapped in" at the transformer lead feeding the neon bulb. This additional stage consists of one NE-48 lamp, a pair of diodes, capacitors, resistors, a tube, and a relay with a set of normally closed contacts. This set of contacts is used to pulse the telephone network and should be tested and adjusted to give the 60% break when used with the encoder in the "tone burst" mode. The relay we used was salvaged from junk telephone relays at the local surplus emporium. Note that this relay operates

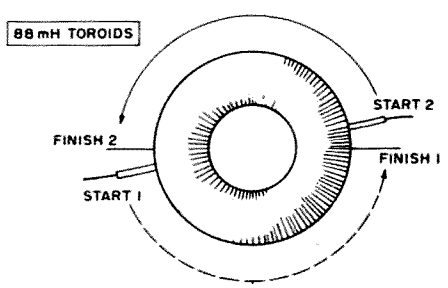


Fig. 3. Sketch shows construction of 88 mH toroids. Connect start 1 and finish 2 together (or start 2 and finish 1); this gives center tap.

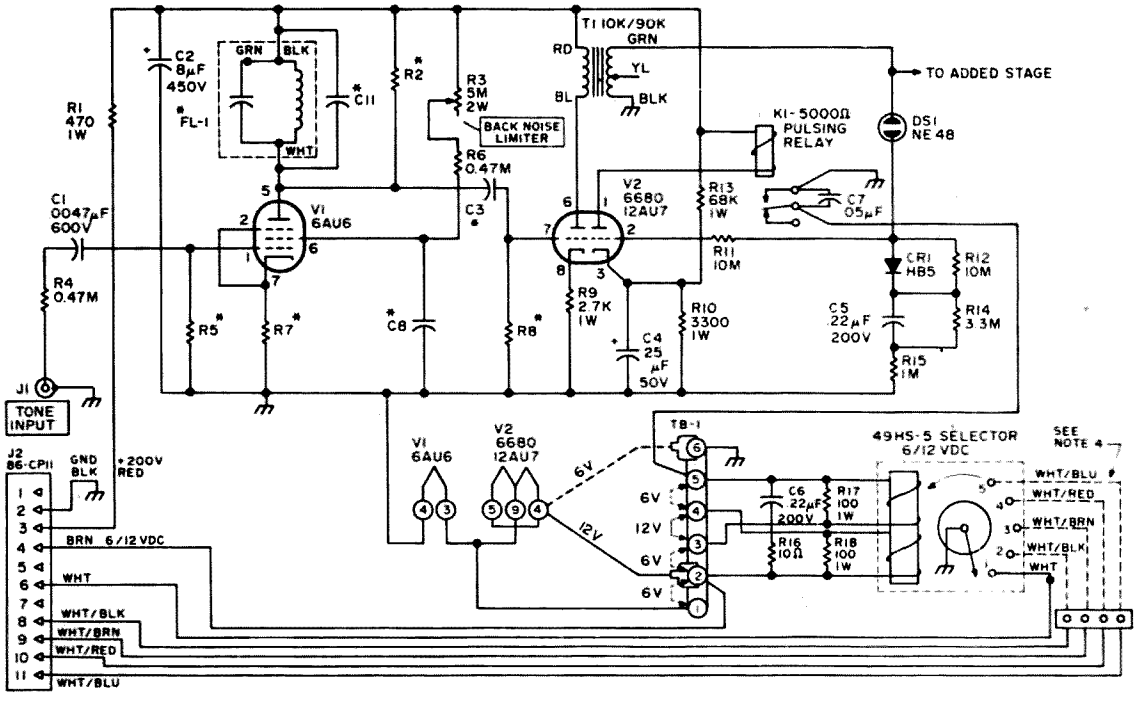


Fig. 4. RPD-612 schematic, digital decoder type 1859.

(the contacts open) any and every time that tone is transmitted to the decoder. Also note that due to the difference of tone on and tone off times in the two modes of encoder operation, the stepper unit in the selector will not operate when "tone burst" is being used.

The equipment used in the channel B repeater (146.22 to 146.82 MHz, operated by Don Pryor, WØIPB) uses the same principles but consists of a modified RPD-650 Secode decoder (transistors and mechanical selector). The Schmitt trigger stage collector load resistor (R22), 4.7K, was replaced by a relay, and the emitter resistor was reduced in value from 180Ω to 100Ω. Since the Schmitt trigger transistor (Q5) is normally conducting with no input signal, we used normally open contacts for our pulsing relay. The model 70 selector was modified by adding the five-function kit and the operation is the same as the other repeater.

Some "tinkering" was necessary to adjust spring tensions in the selector. This tightened the tolerance on the make–break ratio to prevent stepper action during "tone burst." In the RPD-612, the sensing of the make–break ratio is in the electronic circuitry. In the RPD-650 and RPD-650A, the spring tensions of the model 70 selector must be altered to obtain this effect. (The RPD-650 and RPD-650A are made to operate with 75–25 or 25–75 make–break ratio and all variations in between.)

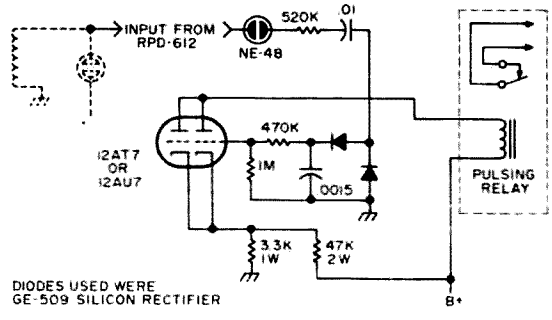


Fig. 5. Secode unit is "customized" for the Wichita repeaters by adding a separate stage for dial pulsing of the phone line.

The Telephone Patch

The first reaction of radio amateurs when they see the circuit diagram (Fig. 6) is usually "where is your hybrid balance adjustment?" Quite simple, since the patch

doesn't use hybrid circuitry and is not intended for simultaneous duplex operation. Since any repeater must have some type of carrier-operated switch, we use the carrier switch to change from transmit to receive. This has a "bonus" – if the radio amateur wishes to interrupt the person on the landline, he simply pushes his microphone button and the landline is no longer transmitting. Very useful to prevent outbursts of unbecoming language from being transmitted. After all, how many two-meter mobiles are equipped for simultaneous duplex operation?

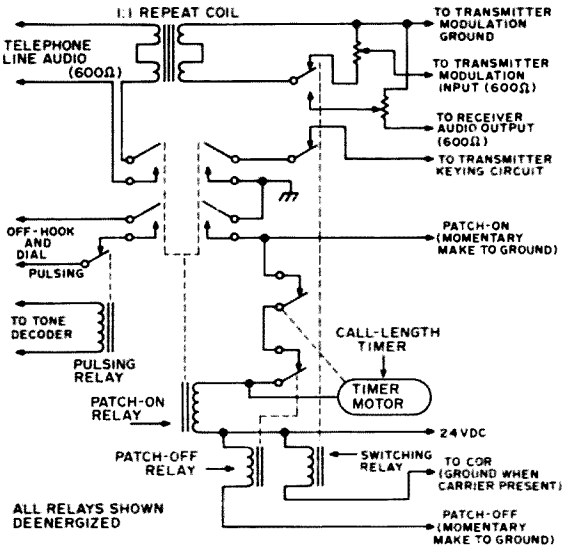
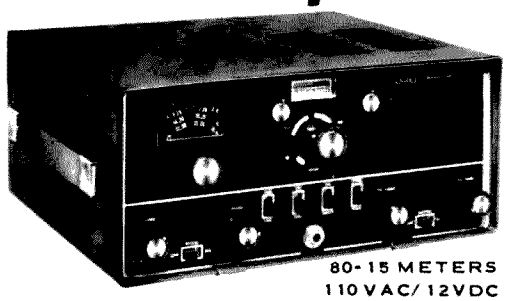


Fig. 6. Schematic diagram of Wichita autopatch radio/telephone interface.

An examination of the schematic diagram shows a pulsing relay, a switching relay, the patch-on relay and the patch-off relay, plus the call-length timer. The pulsing relay is controlled by the presence or absence of tone. The points are closed unless tone is received by the decoder. The call-length timer, a motor-driven unit, opens a set of normally closed points after a preset time interval. The timer begins operation when the patch-on relay is operated; it is returned to zero when the patch-on relay is deenergized. The patch-on relay is held on by a set of points on its own point stack. In the event of power failure the patch-on relay drops out and releases the telephone line. The call-length

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timer and the patch-off relay momentarily interrupt the power to the patch-on relay, again deenergizing the relay. The switching relay is operated by the carrier-operated relay in the receiver.

When no carrier is coming into the repeater, one set of contacts holds the transmitter keyed on while a second set of contacts connects the audio from the telephone line to the transmitter. A transmission by a mobile unit operates the carrier-operated relay in the repeater, which in turn operates the switching relay in the patch. When the switching relay operates, the telephone line is switched from the transmitter input to the receiver output. The contacts used to hold the transmitter on are opened and allow the telephone patch to be used in two ways.

If the patch-on relay is wired to disable the normal repeater keying circuit, the telephone patch operates in a semiprivate mode. The conversation from the telephone to the mobile goes out on the channel, but when the mobile transmits, the repeater transmitter goes off the air (not shown on the diagram). The way we normally use the patch, the carrier-operated relay keys the transmitter in the normal way and both sides of the telephone conversation are transmitted over the repeater channel. Since the "pulsing relay" is open at any time tone is being transmitted, practically no tone is ever transmitted over the telephone line.

Both the channel A and channel B repeaters are General Electric Progress Line repeaters, and are equipped for 600Ω audio input and output. Our phone patch transformer is a salvaged telephone company one-to-one repeat coil obtained from the local surplus emporium.

System Levels

Overall system performance will depend on how carefully everything is set up in the first place. The Wichita repeaters are both wideband. We limit audio levels to 12 kHz for the mobile units. By setting the transmitted tone levels to 9–10 kHz, we do not have chopping to contend with, and the decoders work reliably even when the voice audio is just barely understandable. In most cases, the audio becomes too poor for phone patch quality before the decoder reliability enters the picture. Keep in mind that hard limiting or volume compression will degrade the performance of the decoders. It is extremely helpful if a signal generator with external FM capability is available for testing the system. We have verified that the system is erratic at the 5 kHz deviation level, and is very reliable at any deviation level above 6.5 kHz.

2805 Hz filter

We retransmit the tone through the repeater as we plan to locate muted monitor receivers in various locations to alert needed persons in emergencies. Regular listeners who do not like to hear the tone can use simple filters such as the one shown in Fig. 7 to virtually eliminate the tone. Insertion loss is less than 3.0 dB, with tone attenuation well over 20 dB. We use two of the filters – one at the input to the first audio amplifier stage, and one at the input to the second audio amplifier stage. We use the 88 mH toroids tuned to 2805 Hz with a capacitor and a balance potentiometer. Adjust the potentiometer for the deepest null while checking that the frequency is correct by slight variation of your audio generator frequency. Replace the potentiometer with a fixed resistor and install in your receiver. Possibly higher- or lower-inductance coils would work better – we haven't tried since these are satisfactory.

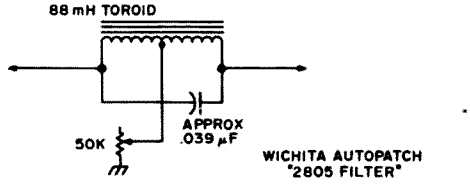


Fig. 7. Toroids can be used as 2805 Hz filters to remove unwanted tone signals from receivers.

Negotiating Permission to Interconnect

This system requires a telephone line or interface at the repeater site. (In the case

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December 29, 1969

Claman L. Sawyer
Civil Defense Radio Officer
Wichita - Sedgwick County Civil Defense
2113 Salina
Wichita, Kansas 67203

Dear Clem,

In answer to your letter of November 10, we have received approval to provide the automatic radio-telephone interconnect. This arrangement is allowable if we provide a standard Automatic Connecting Unit and if the network access line is the rotary dial type.

We do not have a tariff filing for this arrangement; however, it can be provided through a Special Assembly of Equipment rate. This rate will be $7.25 monthly and an installation charge of $20.00 will apply. This service can be provided within 30 days from the placing of an order.

If I can help in arranging for this service, please call me at 268-1376.

Sincerely,

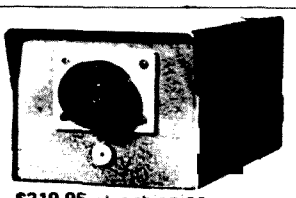
Gerald W. Knox
Special Representative

Fig. 8. Letter from Bell granting permission to connect a "foreign attachment" to telephone line. Note that Bell provides the interface connection — for a fee.

of a split location, it will work at either one.) I made verbal and written inquiries, but for a long time I received no answers. As time dragged on, I made a direct connection to the telephone line, expecting to goad the telephone company into saying yes or no. After several weeks of operation, the Sedgwick County Civil Defense Radio Officer, Clem Sawyer (KØYER), and I mounted a new attack using Civil Defense prestige as a lever. It took six weeks to obtain the permission we sought (Fig. 8). If you wish to connect directly to the telephone line without the telephone company interface equipment, connect the *off-hook* and the *telephone audio* lines in series, connect to L1 and L2 inside the telephone instrument.

Summation and Afterthoughts

Detailed theory of digital pulse encoders and decoders is out of place in this article. Repeater groups wishing to build similar facilities into their repeater should try to locate a friend in the two-way radio business who services this type of equipment. Information on setting codes, multifunction decoders and simple explanations of how the equipment works can be found in the instruction books for General

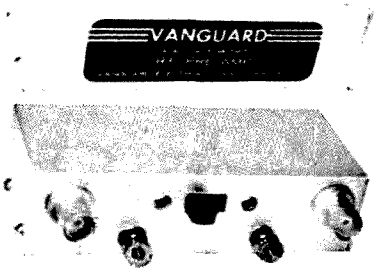


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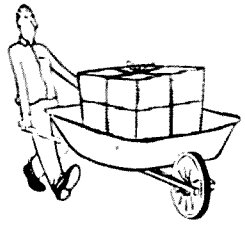
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73 Magazine Peterborough NH 03458

Electric EJ-18A,B,C, and D digital tone decoders, (all solid-state, no relays) and Secode Corporation SD-30 and SD-40 (also solid-state). The General Electric "Datafile" has several folders on Secode encoders and decoders. Local sales and service outlets for Secode Corporation can obtain information for you regarding single and multifunction models of their RPD-673 (12V, for mobile use) and RPD-674 (117V, for station use). Similar types of encoders and decoders are available from Scantlin, among others. Now that a large number of Wichita area amateurs are equipping themselves with the necessary encoders, we are adding features like selectable loose or tight squelch settings, tone key to energize the repeater during skip conditions or temperature inversions (normally the repeaters are to be carrier-energized, but during mild band openings things get hectic), and many others. We may be wiring up more selectors any day now. Transient 2 meter mobiles are welcome to use our autopatch facilities, but they must request the current on and off codes and meet the specifications as given in this article.

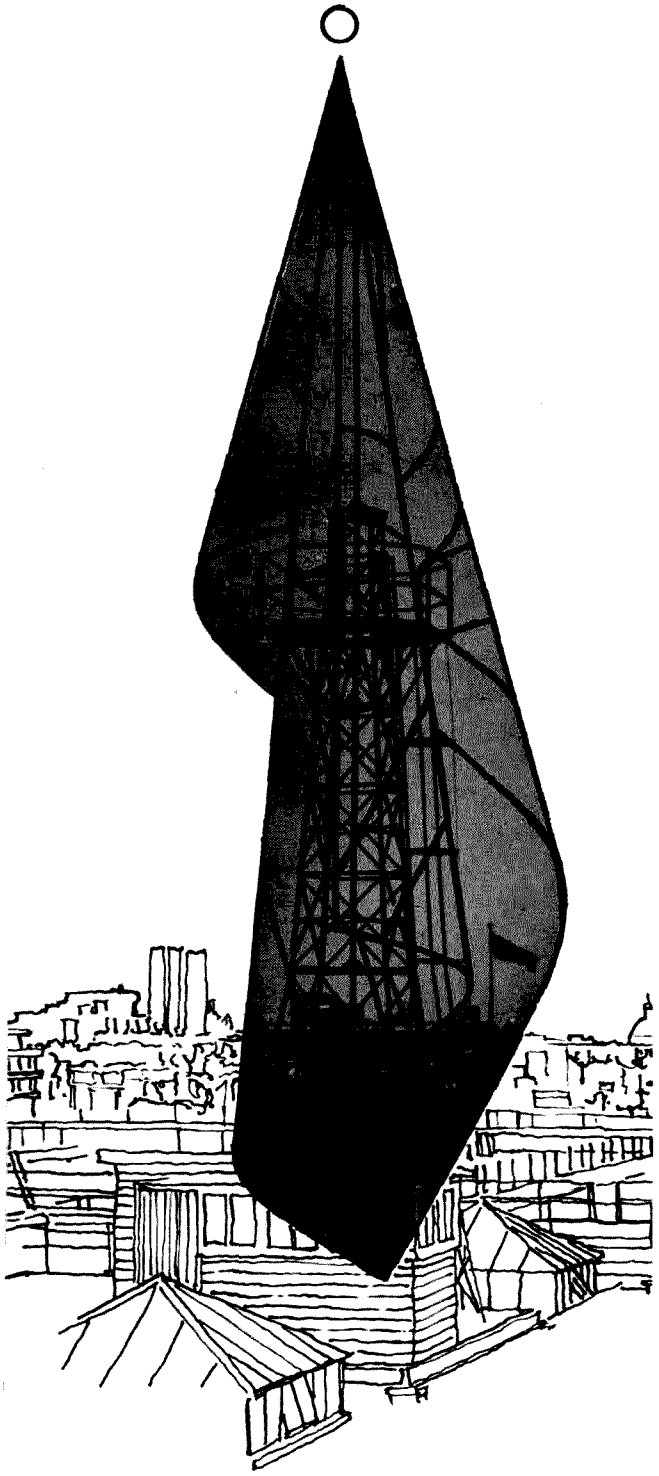
. . . WØDKU ■

Parts List

1 – Dial, Stromberg Carlson or equiv., or W.E. or Kellogg dial, alternate.
1 – 88 mH Toroid, w/added winding, 20–50 turns
1 – Dpdt Switch
1 – Relay, 4 pdt, allied control #T-154 Series CC-CC, 12V, 185Ω Coil
1 – 1 kΩ potentiometer (output lever)
3 – NPN transistors (2N2712)
1 – 200 μF 15V capacitor
1 – .005 μF Mylar capacitor
1 – Capacitor, vary to place on freq., (.035-.04 for 2805 Hz)
2 – 47 kΩ
1 – 33 kΩ
1 – 680Ω
1 – 470Ω
1 – 330Ω
1 – 270Ω
2 – 150Ω
1 – 22Ω
1 – 10Ω

Bruce Ellison
San Francisco
Casas de Binicalaf
Menorca (Balearic Isl) Spain

London's Science Museum Demonstration Station



Mosley beam antenna (TA36-40) on the roof of the Science Museum. Photo from the Science Museum, London.

Few hams can boast of a shack about 35 x 35 feet, two stories high, packed with equipment, most of it lent or donated, and logging between five and ten thousand contacts a year.

In London, England, though, the Science Museum runs just such a station – GB2SM, operating from the second floor of the museum's rambling building in London's fashionable Kensington area.

GB2SM is on the air twice daily – at 11:30 a.m. and 4 p.m. London time (1030 and 1500 GMT) demonstrating the principles of radio communication to an often-eager crowd.

As the station's QSL cards indicate, GB2SM operates with a Mosley TA36–40 beam antenna (on 40, 20, 15, and 10 meters), and Collins KWM–2 SSB transceiver and 30L–1 (500 watt PEP) linear amplifier. Three receivers are in use, and their signals can be put out through two large ceiling speakers.



Part of the main console of GB2SM, the Science Museum demonstration in London.

The station exchanges more than 3000 QSL cards annually.

GB2SM is not strictly an amateur station, as its somewhat unusual call sign indicates. Technically, the operation is a "demonstration station." Call signs in Britain beginning with GB are normally reserved for things like radio shows or conventions, and then on a temporary basis. The museum station is the only one in Britain with a permanent GB call.

Operations were started in August, 1955, to provide a means of getting young people interested in radio communication. Many of the more than 2 million annual visitors to the museum are under 21, and a good proportion of these can be found standing, fascinated, listening to conversation between GB2SM and other parts of the world.

"We know of quite a few young people," says the museum official in charge of the station, "who now hold licenses, and who tell us that their interest was first awakened here." To which staff operator Geoff Voller adds, "I worked a man some time ago who told me that he'd been waiting for a contact with us for years. He said he first got interested in ham radio here and had wanted the contact ever since he got his license."

Voller, a full-time museum staff member, and himself a licensed amateur (G3JUL) runs many of the museum's ham demonstrations. On weekends, and on holidays and vacations, he is assisted by a small group of specially invited British amateurs. Because of the "demonstration station" status of GB2SM, all use the station call sign when operating, never their own call letters.

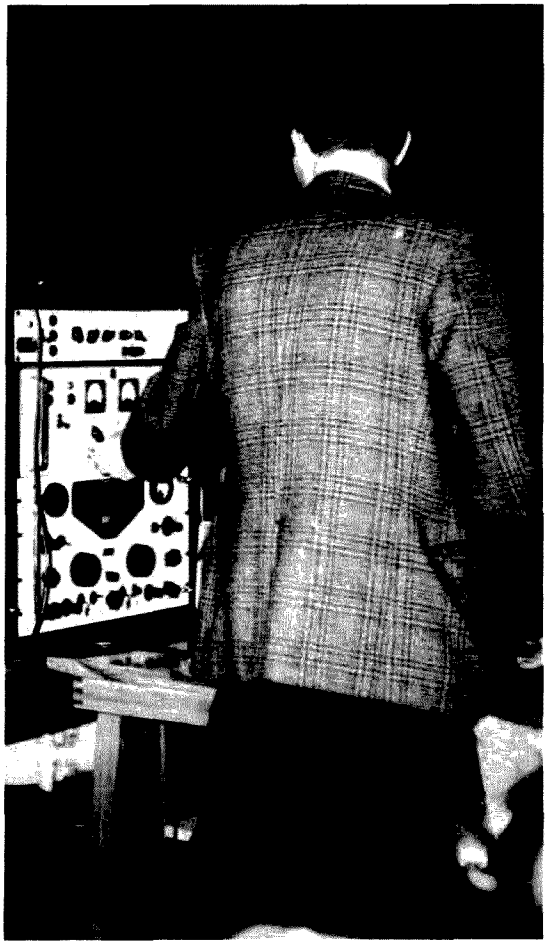
GB2SM maintains regular contacts with several parts of the world; a schedule with ZD9BM in lonely Tristan da Cunha is probably the most interesting of these. The museum station has occasionally proved a valuable auxiliary communications link during emergencies in Tristan.

During a recent morning demonstration, a contact attempt with ZD9BM was unsuccessful. In short order, however, the station logged QSOs with 9VØPA in Singapore and

with WA8RIS in Cleveland, who was calling CQ at the time. A brief contact with WAØITW (also CQ), and with OK2PJ in Czechoslovakia completed the half-hour operation.

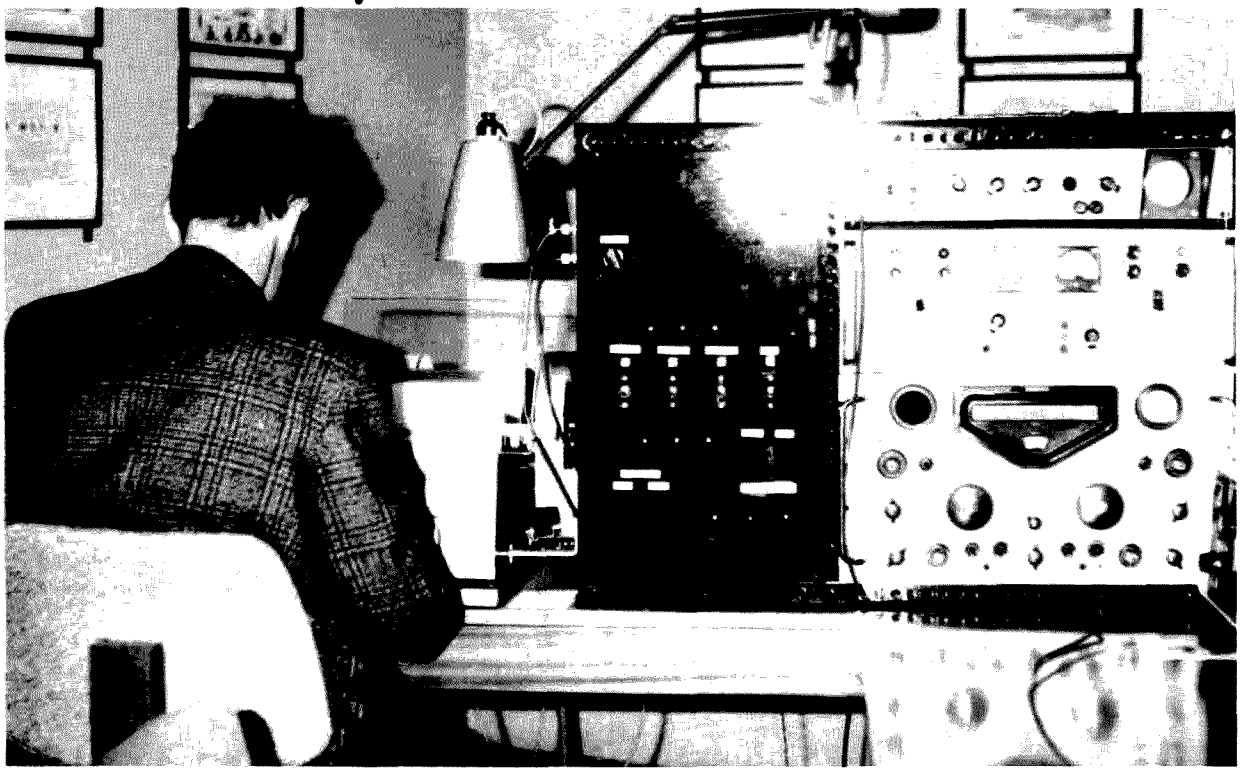
Another morning Voller was "talking" with a friend in Holland via teleprinter, a form of amateur communication much more common in Europe than here. GB2SM maintains a teleprinter schedule with PE2EVO, a demonstration station in Eindhoven, Holland, home of the giant Philips electric firm.

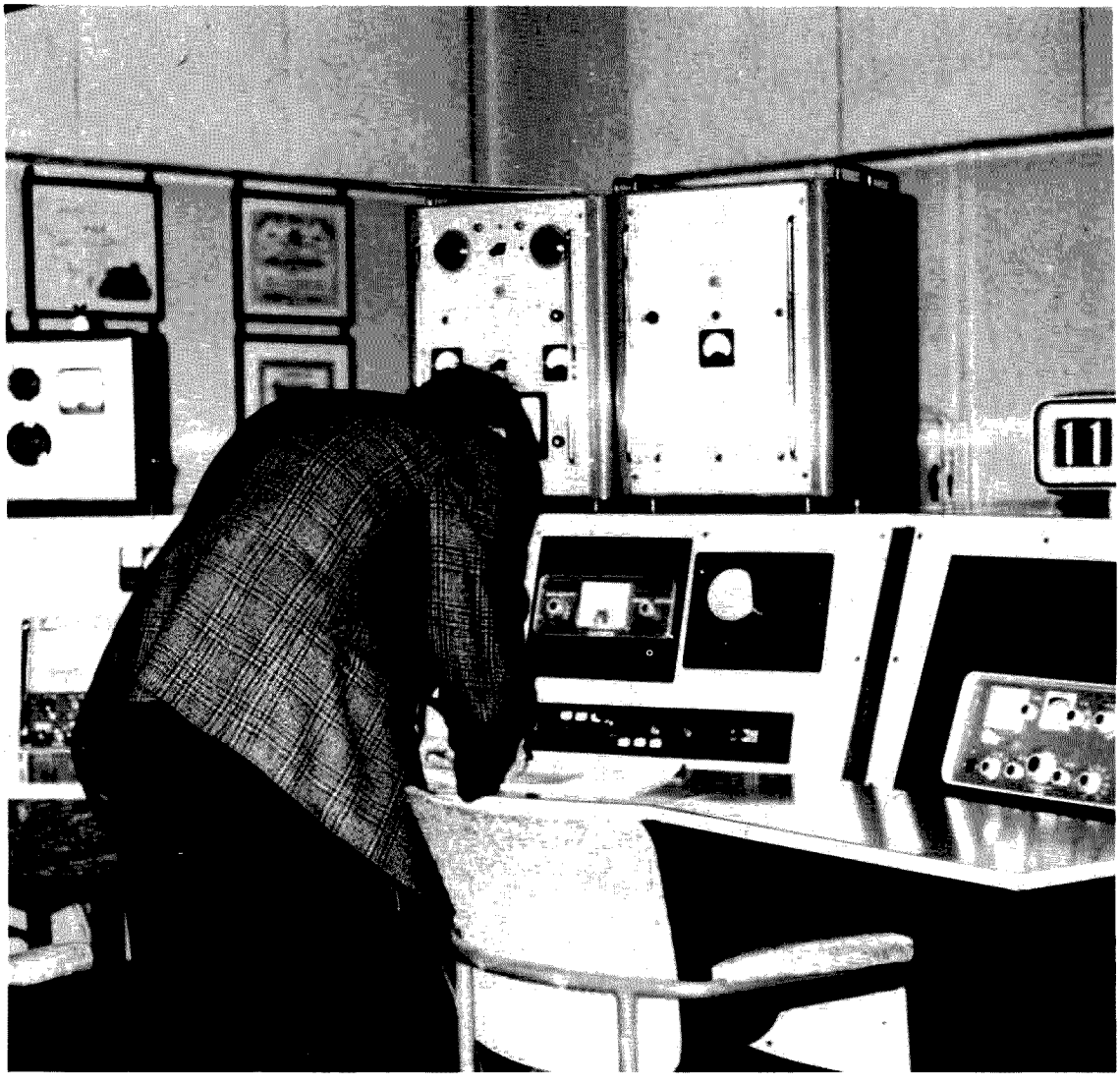
The Science Museum's shack has walls covered with awards. The station enters about two contests a year, each of which requires a high degree of organization and logistic support ("we have to make all kinds of special arrangements to get people into the closed museum at 2 a.m. Sunday – that sort of thing – and keep an urn on the boil somewhere all weekend," says one museum official).



The museum's ham operator, Geoff Voller, adjusts teleprinter equipment during a contact with PE2EVO, in Eindhoven, Holland.

Geoff Voller at work on his teleprinter during "conversation" with Holland. Note awards on the walls.





GB2SM, London, at work. Operator Geoff Voller makes log entries at the conclusion of a half-hour demonstration. Station operates at 1030 and 1500 GMT daily, demonstrating principles of radio communication for a crowd in the Science Museum.

Despite the logistics, GB2SM has more than its share of awards. It boasts such citations as the Keystone award from the Harrisburg, Pennsylvania Radio Club, for being "the first station in England" to work more than 100 hams in Pennsylvania; the ARRL DX Century Club award, and the League's WAS award.

The Radio Society of Great Britain has given the station its "Empire DX Award" for contacts with 50 dominions and colonial areas on 14 MHz, and 50 additional contacts on the remaining bands.

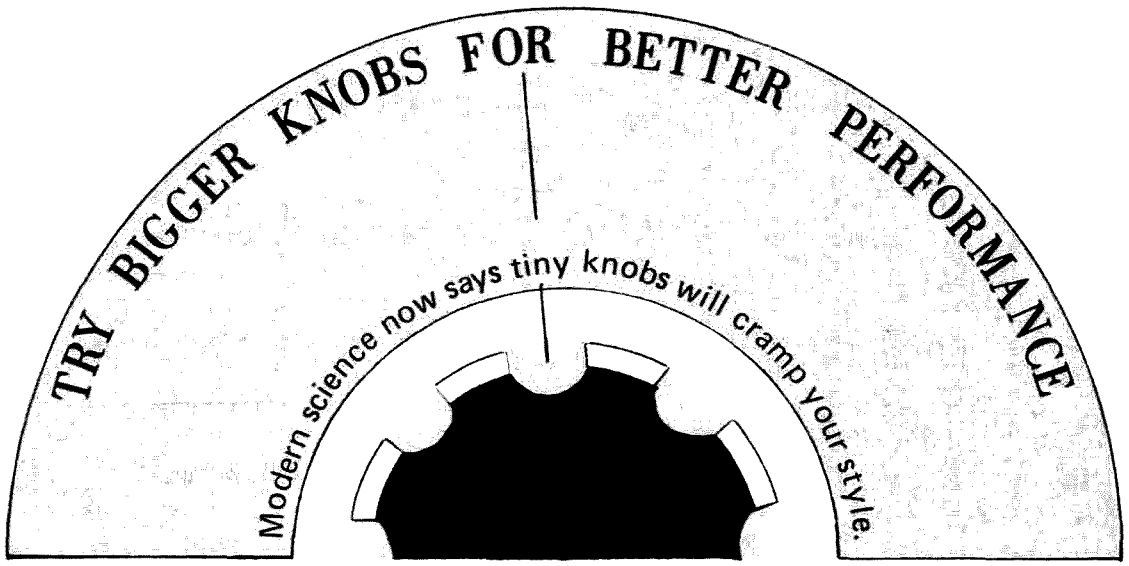
Although the station can operate with code, voice, or teleprinter, most contacts are made with voice because they are the most meaningful to the ever-present audience.

Amateurs visiting Britain are invited to stop in the Science Museum to see the station at work. Its operators rarely see in person any of their thousands of contacts, and are glad of the chance to do so.

There is one restriction, though. GB2SM is not a "public" station, and is not open for use by any visiting amateur. You are most welcome, but the rule must be "please look, but please don't expect to operate."

. . . Bruce Ellison ■

Charles J. Vlahos WB2ICV
15 Indian Drive
Woodcliff Lake NJ 07675



Hardly an issue of 73 goes by without some articles devoted to miniature equipment. Test equipment, receivers, and even transmitters are rapidly going the miniature route. Smaller and compact rigs have much to offer, of course – not only in terms of reliability, stability, and instant warmup because of solid state design, but because they take up less space in the shack.

Yet, for some time I have found an irritating fault with miniature equipment. Indeed, it even goes to standard size equipment. Call it instead an annoyance, or a discomfort. My complaint? Operating knobs are just too small to be comfortably manipulated with efficiency.

I much prefer large, massive knobs on all my gear – whether they be on my tube-type receiver and transmitter or on that little solid state, homebrew transistor checker I often use. So where I can, I install knobs to about twice conventional size.

It's true that some manufacturers (like Hallicrafters, National, and Heath) generally use large knobs (about 1 in. diameter or more) on functions other than the main tuning dial. But most don't. Look at the new lines of transceivers and you'll see what we mean. Most come equipped with tiny, delicate knobs, seemingly designed for a feminine touch.

I'm not much of a contest buff, but if I were, I could offer a couple of strong reasons for large operating knobs. For one thing, larger knobs would eliminate groping, fumbling, or accidental manipulation of the wrong function during hectic QSOs. For another, they would allow you to make critical adjustments with ease (the turns ratio would be in your favor).

Why, then, the trend to small knobs? A hasty conclusion might be the limiting factor of the equipment's basic size. But upon looking over many catalogs and advertisements, you'll find that this just isn't the case. There is usually more than adequate space to double present knob size. So we can conclude that size of rig is generally not a factor.

One valid consideration might be cost. But here again, a check in the current

Lafayette catalog shows the difference between a ¾ in. plastic knob and a 1 in. knob of the same material and design to be a mere 3¢. Fluted knobs, commonly found on most commercial rigs and some well-designed homebrew rigs, have a price span of 4 to 5¢, from the smallest to the largest diameters. So the cost differential that we're talking about is really negligible.

On the face of it, then, there appears to be no meaningful justification for tiny operating knobs. Therefore, if you feel as we do, you can modify your present equipment with larger knobs at a nominal cost. And as for homebrew jobs, there isn't any sound reason for going the miniature route all the way.

At this point you're probably thinking that this entire business of optimum knob size (and shape) is not nearly as important and meaningful as I've indicated. But it is – and here's why:

The space age has ushered in a whole new science called "human engineering" that deals with this very subject. Believe it or not, there are hundreds of engineers around the country who devote their entire time to such things as scientifically determining what size knob, dial, toggle switch, lever, pedal, etc., is best, what material and color it should be, and where it should be best located on a particular piece of equipment. The findings of human engineering have been so revealing to space technologists that even industry is beginning to take a hard look at these results – all in the interest of getting maximum production from machines. The whole idea is to make manipulation of controls as easy and as effortless as possible for humans that have to operate machines of any kind. In other words, it is a science devoted to lessening human fatigue and thus optimizing production.

The implications of human engineering to amateur radio are obvious. The amateur fraternity is always striving to improve, update, and streamline equipment with a view to improving operating conditions. The technical articles in the various ham magazines attest to this. So it appears that knob size is one detail that serious amateurs should not overlook.

An important question to ask at this point, then, is: What is the best knob size? Has human engineering made studies in this area? Have conclusions been reached?

Since an operating knob is basic to virtually all electronic gear, one can rightfully conclude that studies in this direction have, indeed, been made. The findings are particularly interesting and support the author's view that knobs for amateur gear are – in the main – too small.

The August 1969 issue of Human Factors magazine contained an article by J. V. Bradley on "Optimum Knob Diameter." Essentially, Mr. Bradley stated that when frictional resistance is heavy, the best knob diameter is about 2 in. Actually, he described a range of diameters (relating turning time to knob diameter) for such applications to be between 1¾ and 2 in. Anything over and under these diameters is "significantly inferior." What constitutes heavy frictional resistance is something else again. But if we were to classify main tuning dials on receivers and vfo's as those having heavy frictional resistance, then it would appear that both homebrew and commercial rigs adequately meet these specifications.

But Mr. Bradley's article goes on to say that when frictional resistance is reduced to a minimum level, specifications change. Here, human engineering recommends diameters from 1 to 3¼ in. Bradley concludes by saying that these findings are valid over a wide range of rotary inertias.

It isn't often you see rf gain, audio, bandswitching, bfo tuning, or final tuning controls that meet this lower tolerance limit. At one time, when receivers and transmitters came in large packages, they did. But nowadays they rarely do, especially transceivers. Result: smaller knobs and dials.

The next time you put together a homebrew rig of any kind, give some serious thought to large knobs and see if you don't feel a bit more comfortable with them. Or better yet, try installing larger knobs on those appliances you have now. You'll see what we mean.

. . . WB2ICV ■



NEW PRODUCTS

Low-Cost Function Generator

Phase Corporation is marketing, as a kit or wired and tested, its low-cost solid-state test oscillator, which generates square waves, pulses, or sawtooth waveforms from 0.1 Hz to 100 kHz. Portable and compact, the package contains FET and unijunction circuitry to cover the operating spectrum in six continuous ranges. In the kit form, which sells for $34.95, all parts are included: transistors, diodes, switches, etched and drilled printed-circuit board, custom cabinet with screened and punched



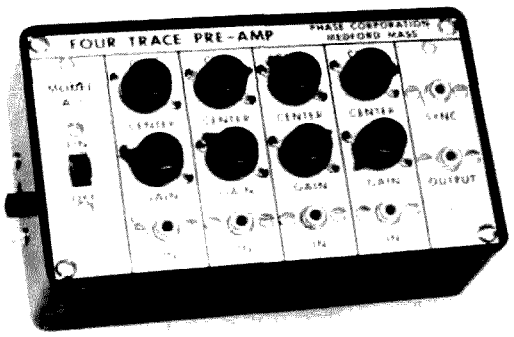
front panel, and easy-to-follow assembly instructions. The Model 01K designates the kit; 01W is the completed package, which sells for $54.95. (Both prices include postage within the continental United States.) Specifications for the Model 01 test oscillator are as follows:

Output 8V p-p, all ranges
Output Z 5 kΩ
Freq.
Sawtooth and pulse: 0.1–100,000 Hz
Square: 0.05–50,000 Hz
Risetime
Square and pulse: 0.5 μsec
Pulsewidth
1 μsec at 100 kHz
5 msec at 2.5 sec/Hz

Phase Corp. is located at *315A Boston Ave., Medford, Mass. 02155.*

Four-Trace Oscilloscope Preamp

A four-trace oscilloscope preamplifier, the first in a new line of kits, has been announced by the *Phase Corp.* The preamp is designed for use with any ac or dc oscilloscope, providing the capability of observing as many as four waveforms simultaneously. Individual centering control is provided for each of the four inputs to the preamp. With an input impedance of 1 megohm/channel, the sen-

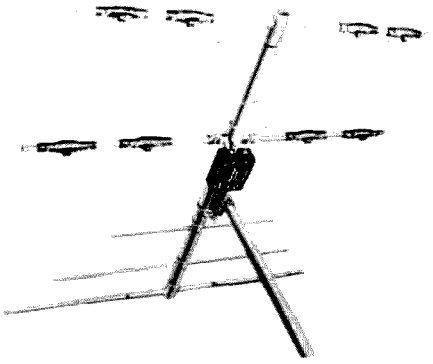


sitivity of the preamp is limited only by the sensitivity of the scope with which it is used. The preamp is compact, facilitating mounting inside the scope housing or in an optional case. The circuit of the preamplifier employs four FETs and nine silicon transistors. Included in the kit is a printed circuit board that comes etched and drilled.

Phase Corp., 315A Boston Ave., Medford, Mass. 02155.

Challenger Beams Are Design Innovation

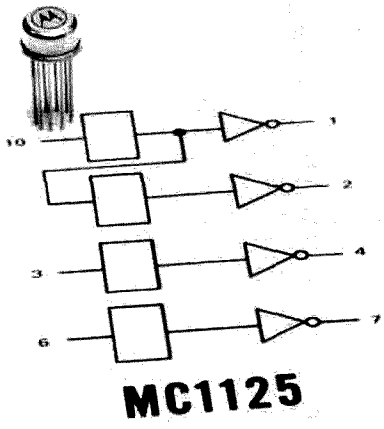
The Challenger line of antenna systems feature a balun-fed, 5-element Tri-Band array for operation on 10, 15, and 20 meters using a single transmission line. It has a peak power rating of 1 kW and a 28 dB front-to-back ratio.



Other Challenger models range from 3/4 through 80 meters. The entire line, as well as other Telrex antenna systems, are described in Catalog PL70 which is obtained free by writing to *Telrex Labs, Asbury Park, N. J. 07712.*

Monolithic Synthesizer MOS

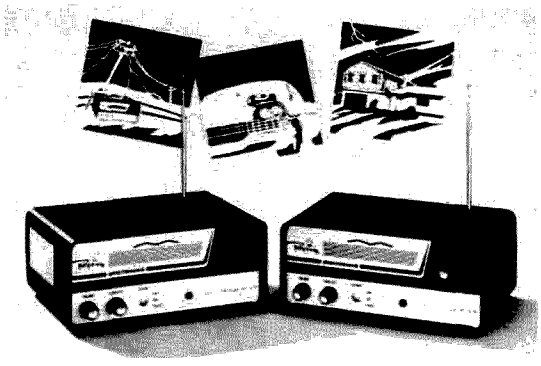
Motorola's MC1125G is a monolithic, quad MOS device consisting of four toggle-mode flip-flops with buffered Q outputs that use no standby power when driving capacitively coupled loads. Typical power dissipation is a low 75 mW and operation is from dc to 1 MHz. The MC1125G also



features a typical input capacitance of 2.5 pF and a crosstalk figure under 1%. The MC1125G is recommended for frequency synthesis, as required in organ circuits, digital dividers, and counters. *Motorola Semiconductor Products Inc., PO Box 20912, Phoenix AZ 85036.*

FM Receivers Have Built-in Decoder

Two FM receivers for operation in the 50 and 144 MHz bands feature a complete assortment of optional equipment, including a sequential tone alarm decoding facility. The radios are available in four model designations. Model TM II-H1 has a single-channel, narrowband reception capability in the 144–172 MHz band. TM II-L1 is the same for operation in the 30–50 MHz range. List price for both models has been set at $115.00, including crystal. Models TM II-H2 and L2 feature 6-channel reception capability in the respective fre-



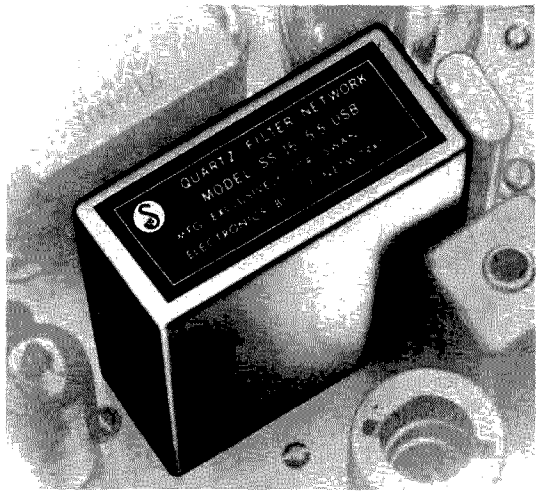
quency ranges at list price of $130.00, including 1 crystal. (Additional crystals are priced at $4.95 each.)

The receivers are being built as replacement units for the original TM series. New circuitry, however, enables the radios to deliver better performance without price increase.

Sensitivity for all models is rated at 0.5 μV. Selectivity is set at 50 dB at ±15 kHz. The receivers operate on 117V with accessories for 12V dc or internal ni-cad battery power supply. *Regency, 7900 Pendleton Pike, Indianapolis IN 46226.*

Quartz Filter Offers Super Selectivity

Made exclusively for Swan by CF Networks, an all-new 16-pole quartz filter network establishes a dramatic standard of comparison. Shape factor of 1.28, ultimate rejection greater than 140 dB! A giant QRM killer, the SS-16 wipes out strong adjacent channel interference with unprecedented attenuation. And in transmit



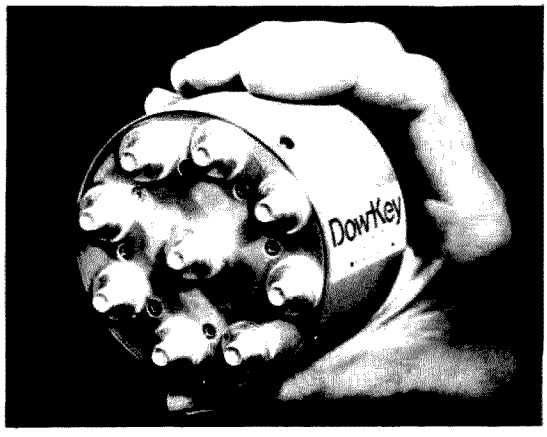
mode, unwanted sideband and carrier suppression are both increased greatly. Available only for Swan transceivers, they are made for the current 5.5 MHz i-f, or earlier 5.175 MHz i-f system. Installation and adjustment are simple. Specifications are as follows:

- 2.7 kHz bandwidth at 6 dB down.
- Shape factor 1.28.
- Ultimate rejection: 140 dB.
- 16 poles. 16 precision crystals in a lattice filter network.
- Sideband suppression: 80 dB.
- Carrier suppression: 45 dB with the filter alone, plus approximately 40 dB more from the balanced modulator.
- Mounting: Same as standard Swan filter, but taller.

Swan Electronics, 305 Airport Road, Oceanside CA 92054.

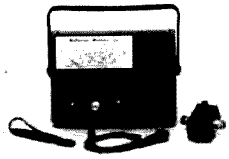
Remote-Controlled 8-Position Coaxial Switch

The Series 74 coaxial switch is intended for use in 50Ω circuits at frequencies up to 2 GHz, where the multiple sources are switched to a common output. To provide maximum isolation, all unused terminals of the new switch are



grounded. In standard configuration with type OSM connectors, the switch measures 3 in. diameter by approximately 2¼ in. deep. Other connectors available include types BNC, TNC, 27 series, and MB. The switch is normally supplied for operation at 26V dc. Other voltages available are 6, 12, and 120V dc. *Dow-Key Co., Box 348, Broomfield CO 80020.*

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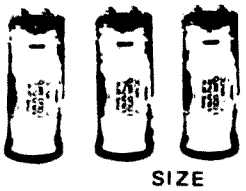
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25,000 MFD- 6 VDC	2" x4½"
30,000 MFD- 10 VDC	3" x4½"
60,000 MFD- 5 VDC	3" x4½"
20,000 MFD- 15 VDC	2½" x4½"
15,000 MFD- 15 VDC	2½" x4½"
35,000 MFD- 12 VDC	2" x 6"
7,000 MFD- 13 VDC	1 3/8" x4½"
3,000 MFD- 25 VDC	1 3/8" x4½"
2,500 MFD- 45 VDC	1 3/8" x4½"
3,750 MFD- 75 VDC	2" x4½"

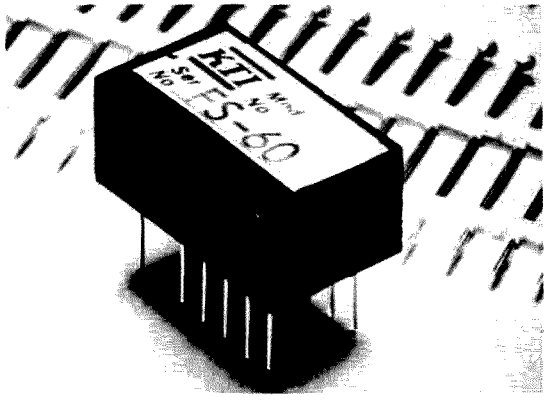
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Active Filter Features Low Power Consumption

A new hybrid active filter, the Model FS-60, requires only 0.3 mW of power at ±2V, making it particularly suitable for use in battery-operated equipment. The unit sells for $10 in large quantities. Operating in the frequency range from dc to 10 kHz, the FS-60 features multiloop negative feedback for high stability and a Q range from



0.1 to 500. Other key specifications include a voltage gain adjustable to 40 dB and the ability to attain complex zeros anywhere in the S-plane. Bandpass, highpass and lowpass outputs are available simultaneously. The filter employs encapsulated hybrid circuit construction and is housed in a 14-pin dual in-line package measuring 0.804 x 0.336 x 0.474 in. Complete specifications and additional pricing data are available from *Kinetic Technology, Inc., 3393 De La Cruz Boulevard, Santa Clara, Calif. 95051.*

Those DGP Maps

The three-dimensional maps that DGP Company is distributing make the normal topographical maps look like junky gas station maps. These not only are a great help to anyone working on VHF, they are about the last word in a fancy wall map. Businesses are grabbing these up for decorating their walls, they are going up on hamshack walls, and they are being used as gifts for sportsmen.

The detail on these maps is hard to believe. They get right down to even the little dirt roads! Each map covers an area about 100 miles by 70 miles and every mountain is clearly shown both with con-



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A3003	923	TO-5	JK Flip Flop	1.00
A3007	3M4-923	FP	JK Flip Flop	1.00
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A4009	1N3255	RCA Rectifier PIV 600, 500 ma	10/1.00
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A4050	1N2071	Sylvania Bullet Diode PIV 600, 750 ma	8/1.00

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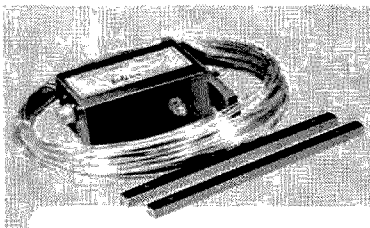
tour curves as with the topographical maps, but also by being raised. The raising is exaggerated by a three-to-one factor to make the mountains really stand out. These are the most detailed maps ever produced and were done from actual 3D aerial surveys.

Any time you find yourself stuck for a great gift for a friend (or yourself), one of these 3D maps will make a lasting impression. *DGP Company, Box 431, Jaffrey NH 03452.*

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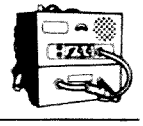


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Army Manual

The "Tech Manual" format for March is the best yet! Kudos to whoever thought that one up!

Fritz WB4MSJ

There were many comments from our ham-type technicians regarding your March issue on the front cover. All in all, they thought was a darn clever idea and they also made many nice comments regarding the quantity and quality of technical articles. I thought the amateur radio news page in the March issue was most interesting and I have removed these two pages and put them on the company bulletin board.

R.A. Kobold
Manager, Cust. Svc.
Galaxy Electronics

Cover Award
March 1970

Originality	10
Color	10
Copy	10
Type	10
Layout	10
Design	10
Content	10
Technical	10
Paper Stock	10
Appearance	10
Total	100

Congratulations
de WA4NED

Re – the March issue – clever cover. The "NOT-TOO-TECHNICAL MANUAL" bit is especially right. Did you check pages 62 through 67? The guy (Bob Manning K1YSD) must be sick.

Everett G. Taylor W6DOR
4100 Worthington Dr.
North Highlands CA

Y?

A couple of things. First, as a professional communication engineer, I am enjoying those Extra Class articles. But tell me, what little gremlin, or type lice, made off with the letter Y in Table 1 on page 101 of the February issue???? Especially since RY is one of the favorite test letters on the circuits, along with the quick, brown fox.

Next, the February issue was delivered here in San Diego on 20 February, so those announcements of events happening before then were of only historical interest (whatever that may be). Looks like you should insist on a longer lead-time if the item is to be of value.

Les Harlow WB6ZNW
5015 Cape May Ave.
San Diego, California

My question is: Y?

You left it out of the RTTY list on page 101 of the February 1970, 73 Magazine.

And 'Y' is so important – it's the other half of 'RY' one of the most familiar terms in RTTY.

C.L. "Bob" Engelbrecht VO1BL
31 Cowan Avenue
St. John's, Newfoundland

Yoiks! Y is coded 1-3-5 and it most assuredly is one of the important letters for TT'ers.

. . . Wayne

League Representation

As a relative newcomer to amateur radio and a subscriber to your magazine I am only disappointed in one thing, that your magazine doesn't come more often. I feel as I'm sure most of your subscribers do, that you are the only ham amgazine which truly represents the amateur.

By all means amateur radio should have a lobby in Washington, if the ARRL doesn't push for a lobby we should ask who are they representing, amateur radio or their own little station in Conn. If the ARRL doesn't react on this it's time everyone reacted on them. I myself am not a member of the ARRL and do not intend to be until I feel they would be representing me and not their own interests.

As I have mentioned previously I am truly in love with your magazine. There has not been one article which I have left unread and undigested. It's truly worth every cent of it's price, even if you have raised the price. Now I'd like you to listen to one of my gripes. Even though I am a Novice I do spend most of my time scanning across the phone bands. And I must say I'm very disappointed with the general conversations. Now don't get me wrong – listening to a ham tell another how he gets such great modulation excites me just as must as the latest hit record, and I'll have some fish stories to tell too when I get my General, but is this all hams have to talk about? When is the last time you heard an on the air debate about the latest FCC proposal or some discussion over an amateur lobby? What I propose is this, a net be established to talk over these things, a place where some meaningful discussion might take place. 73 and other magazines might keep the net informed of latest developments and an FCC-net hotline might be established. Wayne and other writers might have some on-the-air editorials to promote discussion. Other subjects might be discussed which generally bring to harsh a reaction from the general ham population, such topics might include, SEX, RELIGION, and POLITICS. Anyone could therefore tune in on the net and find out what's happening on the amateur scene today. Some amateurs who don't subscribe to 73 aren't even in the right decade. I think that the net would be especially inspiring to SWLs contemplating becoming hams and Novices interested in becoming Generals.

Tim Rulon WN2KQD
12 Morahopa Rd.
Centerport NY

Urgently request your leadership in promotion of FM thruout amateur world. In my humble opinion FM has the potential to nullify CB, restoring Amateur Radio to its rightful place in public service. The excellence of FM as a communications mode for civil defense, etc. will bring about a revision of trends and policies,

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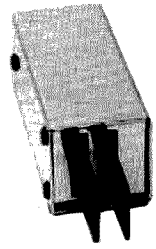
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swinging public service back from CB to ham radio. Only hope the League isn't too blind to see this obvious fact nor too set in their ways to realize FM's potential to rescue amateur radio. I am confident in you and your staff to provide interim leadership and technical information until Newington's Ponderous Pachyderm starts to move. Can anything kill their apathy?

M.N. DeBlasio WA2HCD

We agree that FM has the potential to nullify the inroads made on public service by CB – which could prove highly beneficial to amateur radio.

. . . Ken

Big Brother

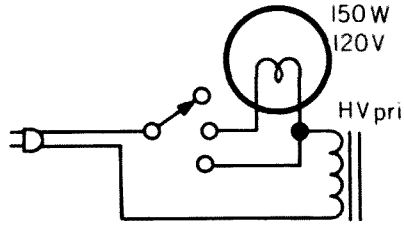
I wrote a letter to the League suggesting that instead of taking frequencies away from us, they should request the FCC to open new frequencies to us as an incentive. My reply from headquarters stated, in essence, that we should trust in the judgement of big brother in that they know what is best for us. Bully for them.

Earl WA1KYW
7 Randolph St.
Arlington MA

Killing the Big Thump

For better than two years now I have been fooling with an 813 GG linear (two in parallel). It is built entirely of surplus *junk* (and I mean that in the strictest sense of the word!).

One of the biggest problems was the power supply which is made up of a 2500–0–2500 power transformer, 866 filament transformer, 1616 rectifiers (I used to have 866A's. . .they are directly interchangeable), and two *gigantic* oil-filled filter capacitors. With power supply turn-on I'd get the "big thump" and the most beautiful flash in the 1616s! It would then proceed to blow the 10A slo-blow's in the line plug *plus* the 20 amp circuit breaker in the shack!



I went through 6-866A's, and 4-1616's and kept thinking it was *scrounging* soft or bad rectifiers. The fact is, they couldn't handle the terrific surges!. I became aware of this fact after reading an article by R.T. Brackman and M. Weinschenker (73, Page 77, Jan, '70) on silicon rectifier diodes. I never realized there could be that much surge. In the Jan. '69 issue of 73 Mag. on page 22, W9VEY offered a solution. I didn't like this simply because I did't have a spare relay and the 20W, 5 kΩ resistor.

So. . .in my power supply I wired in permanently a 150W light bulb in series with one of the primaries. This is turned on first and then after a few seconds is shorted out to let the full 2500V in. This serves two purposes. . .one-it got rid of the "big thump" and the ensuing "big blow" by fuses, and two-I now have a 800V low voltage supply built in!

The light bulb is mounted in a plplug-in type light bulb socket so that if I have to change

bulbs, all I have to do is unscrew the old one and screw in the new one. It is mounted on a rotary switch.

Wayne Jinske WA9SSH
Custer WI

I wonder if it is not possible that Wayne's editorial stand concerning the League is not having some undesireable side effects.

Have you listened to W1AW code practice lately? Could it be that some of those who like to tune up on top of the code session or come slipping in from the Northeast over it might feel they are in their own way supporting Wayne in his battle with the league? I do not think 73 wants that sort of support. Perhaps these individuals do not listen to anyone or any publication. In any case I, in behalf of others who use the code practice service, would appreciate your help.

Bob Cutler WNØYED
Glenwood Springs CO

The FM Route

My wife and I just got back from a vacation trip of 2 weeks on the newest of highways: the new 146.34-146.94 open repeater FM highway.

I have been an amateur for many years, but never enjoyed anything as much as this trip on the highway open to the amateur today. As soon as we got 50 miles from Bloomington, Ill., I took the mike and said, "This is W9JFP/9 mobile." From there on, I had company all the way to California and back with the open repeaters on .34–.94 FM. Made hundreds of contacts – all so friendly I couldn't believe this was amateur radio. I was 60 miles from Tulsa and listening on .94 and a very pleasant voice broke squelch with: "This is WA5LVT, Tulsa Repeater; the time is 6:00 a.m." This was heard every ten minutes for the time I was in range, which was about 60 miles either side. Near San Diego I called but heard only a few stations and no responses, because this was an exclusive tone operated closed group; same story in Los Angeles, but on the way home, when we were 60 miles from Las Vegas, I got a reply from the open repeater in Las Vegas; and all the way back to Milwaukee, for 2200 miles of driving, I had company almost continuously thanks to my trusty 4Iv (which is old enough to retire) and the open repeaters on 146.34/146.94 FM. When we got within range of Chicago again in the exclusive area, couldn't make a contact because the repeaters were not open. All I can say is thanks to you and the 2 meter FM open repeaters.

Vic Weissbrodt W9JFP

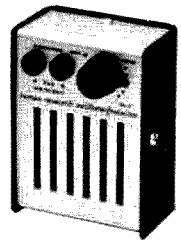
The Chicago repeaters are open to transients, Vic. But the output there is 146.75 MHz because .94 is too active on a simplex basis. The stations you heard in San Diego were undoubtedly the same ones you heard in Los Angeles – Remotes Operated By Insociable Nets (or "Robin," as it's called in California.)

. . . Ken

FM Fringe Area

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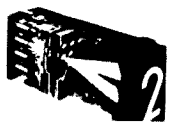
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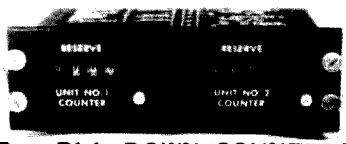
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Mid-Missouri is a fringe area of VHF, but it's coming along, especially on FM (146.94). Keep those VHF articles coming and congrats on a fine magazine; the March issue was beautiful!

Jos. McGrew III WAØZIK
Eldon MO

On Spectrum Utilization

I have just recently returned to stateside 40 meter operation and found the QRM level near that experienced overseas. So I would like to pass on to you my thoughts on the usage of amateur frequencies by broadcast stations. Here are two possible avenues of attack to remove some of the congestion from the air.

First and probably the most likely to show results in cost versus listener audience. I should think that the SWBC cost of transmission far exceeds the justification by number of listeners.

With the present budget cuts, the time seems right for amateurs to point out the cost of broadcast compared to that of amateur radio. On the transmitting end, broadcast is expensive and amateur radio costs practically nothing – and on the receiving end, SWLs pay nothing, while amateurs pay to be licensed.

Now the second course, by the very presence of broadcast stations in our bands, it would seem that they are not concerned by the interference we cause. When you consider the difference in power levels between amateur and government transmitters we can do them little harm; therefore, I suggest some joint frequency usage. In the 21 MHz band (above 21.450) hams could easily squeeze in contacts if cost reductions took some transmitters off the air and hams were allowed to fill in the gaps. I admit we would be competing with those who "come up on any clear freq" but we live with them now.

Stephen Miller WB6TVT (KA2SM)
San Diego CA

Dockets

The FCC has recently issued a notice of proposed rulemaking concerning, among other things, (1), Amateur radio license fees, and (2), VHF repeaters. I have the following objections:

(1) The increase in license fees would be in direct opposition to the Federal Government's anti-inflationary policy. An increase in fees to the suggested level would make the cost of a license prohibitive for many amateurs, and when the fees are further increased in the future, as would inevitably be the case, amateur radio might possibly become a thing of the past owing its demise to being "licensed right out of existence."

(2) Regarding the propositions to (a) eliminate crossband links on VHF repeaters, (b) confine the repeaters to specific segments of the 6 and 2 meter bands, and (c) limit the power output to 250 watts, I am in direct opposition to all three proposals. Since VHF repeaters are amateur stations licensed to amateurs as remote control transmitter locations, the proposals named above, (a), (b), and (c) are all in direct conflict with amateur licensing rules and operator privileges as stated in the FCC rules and regulations. Amateur operation is permitted on the bands according to the class of license held by the operator and method of modulation employed, NOT according to type of operation. This cannot be regulated in the proposed way

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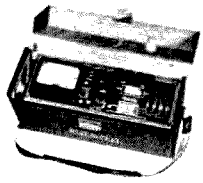
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unless the current rules and regulations concerning operator licensing and privileges are greatly altered. Hence, the proposals to confine VHF repeater operation to certain segments of the authorized bands and limit their power output is in direct violation of the current rules and regulations.

The proposal to eliminate crossband links on repeaters would greatly inhibit repeater activity and growth, and would make it impossible for many repeaters now present to continue operation. This provision also violates all previous FCC policy because crossband operation (AØ) is presently acceptable on all bands above 51 MHz according to the current rules and regulations.

The inhibiting of VHF repeater activity and future growth would present a great setback to emergency communication networks, and thus the FCC, by adopting these proposals, would be greatly reducing the ability of amateur radio to serve the public interests, which is also in obvious conflict with present FCC policy.

Thomas McLaughlin WB4NEX/9
N. Manchester IN

Open Letter to Hams Everywhere

Dockets 18802 and 18803 endanger the existance of amateur radio as we know it today. Individual and group action on these dockets can help, provided that both individuals and clubs respond in the form of comments to the FCC *and* cards and letters to congressmen and the White House.

Note that the ARRL has not been a party to Docket 18803 other than to verbally support the Buffalo petition. Unfortunately, the only part of the Buffalo petition that filtered into Docket 18803 has to do with logging and tone access. ARRL is opposed to 18802 on grounds that the amateurs do most of the work in licensing and policing the bands themselves.

Three steps should be taken immediately...

1. Request an additional 30–60 days for reply comments on Docket 18803. The mechanics of obtaining comments filed – in order to file reply comments – requires more time for reply comment filing.
2. File individual and group comments on Docket 18802 as soon as possible.
3. Write to your Senator, Representative, and the President expressing your feelings on these dockets. (This pressure will also be felt back at FCC.)

Copies of comments should be retained for future use – it will do no harm to send a copy to ARRL also. In this way you let them know your stand.

Need a Xerox? FCC needs the original plus 14 copies of everything you send them. The New England FM Repeater Assn. will make copies of comments from individuals only – if the original is sent to us.

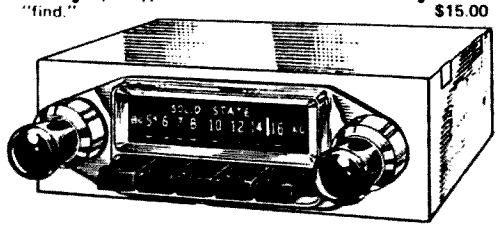
Gordon Pugh W1JTB

Two-Party System?

With advent of incentive licensing, I sort of lost interest in ham radio and let my subscriptions to the four mags lapse. Recently, I came across your Dec. '69 issue and after having read your remarks on the ARRL and reviewed the other material in it, my interest was stimulated to the extent that I am herewith renewing my subscription for three years. I would like to see

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another group form similar to the ARRL, but with more progressive ideas and better representation of the amateur body. Certainly others in hamdom must entertain this idea. You have the vehicle in 73 to bring them together – why not do something in a positive direction about it? We have a two-party system in government – why not the same in ham radio?

Dick Dunn W1BPM

Wayne – In your article "ITU Conference: Who lobbies for Ham Radio?" I think you have made a statement that is in error. If I interpret it correctly, you say ARRL is a "tax-free" organization because it is a "non-profit" organization and you state that they cannot legally register a lobbyist to represent them with congress.

I base my reasoning that you are mistaken in this matter on the fact that the March 1970 issue of the American Rifleman, the Official Journal of the National Rifle Association of America, states that it "is an independent nonprofit organization supported by membership fees" and, in an article titled "A Statement" by the president of the National Rifle Association, it is stated that "We do have a representative registered under the Federal Lobbying Act for the purpose of necessary contacts on national legislation affecting the rights of gun owners."

Hence, Wayne, if it is legal for the NRA to have a lobbyist would it not also follow that it would be legal for ARRL to do likewise, if it wished to?

Clayton C. Gordon W1HRC
P.O. Box 85-West Main St.
West Millbury MA

Nonprofit does not mean tax-free. You will find that the NRA is not tax-free, that they are paying their way like any other business even though they are nonprofit. The ARRL saves thousands of dollars a year by being tax-free and this means that they cannot by law register as a lobbyist in Washington for amateur radio.

. . . Wayne

Democratic?

Would you perhaps like to mention in a future column that while ALL licensed amateurs are eligible for "FULL" membership in the ARRL, only those holding a general or higher class license are eligible to hold office. A quick look at the breakdown of licensees in the callbook will convince you that the ARRL is not by any meaning of the word a democratic organization. As a number two punch you might look into the awarding of the Ø QSL bureau. I understand that this situation stinks to high heaven too.

Col. D. Lester W1AER

The League system of government is comforting to those in charge and a frustration to any members who are concerned over League HQ actions. The March 1970 QST editorial tells members not to write to HQ, just to their directors, if they have a complaint. The feeling, right or wrong, is that writing to the director is futile since this "representative" appears at HQ but one or two days a year of highly structured routine meeting work. This means that the possibility of any individual being represented is virtually nil. The boss that comes to work one or two days a year has no real idea of how the business is really going, no idea of the competence of the employees, and no opportunity

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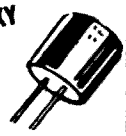
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whatever to hire and fire employees, no matter how bad things may get. The employees are the ones running the company in this situation, not the bosses (directors).

. . . Wayne

Printed Circuits

I have just finished reading with some interest the PCB article by Ken Sessions, and would like to pass along a few additional hints for the benefit of those readers who are not familiar with circuit board fabrication. I have used these methods both for "homebrew" projects and also for the building of several items which have flown in NASA sounding rockets and other space-qualified hardware, they have worked out quite successfully with high resolution boards. We have achieved, at best, conductor widths of .02" and spacings of .05" under conditions which most amateurs can duplicate using conventional photo methods. However, back to the hints for use with the Bishop system.

A "bug light" of 60 to 100 watts is quite satisfactory for a safe working light while working with sensitized boards, and gives quite adequate light levels.

A low-cost UV exposure light can be made from a desk-type fluorescent lamp by replacing the normal bulb with a "blacklight" lamp that emits light primarily in the violet and near-UV. Hope these additions to the info already given will be of use to someone wanting to turn out some home built gear. There are too few builders left on the ham bands.

Jack Dugan W2IAX/2
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AUSTRALIA	21	21	21	14	14	14	14	14	14	14	21	21
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U. S. S. R.	7A	7	7	7	7	7B	14B	14	14	14	14	14

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ARGENTINA	21	21	14	14	14	7A	7A	21	21	21	21	21
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CANAL ZONE	21	21	14	14	14	14	14	14A	21	21	21	21
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A = Next higher frequency may be useful also.

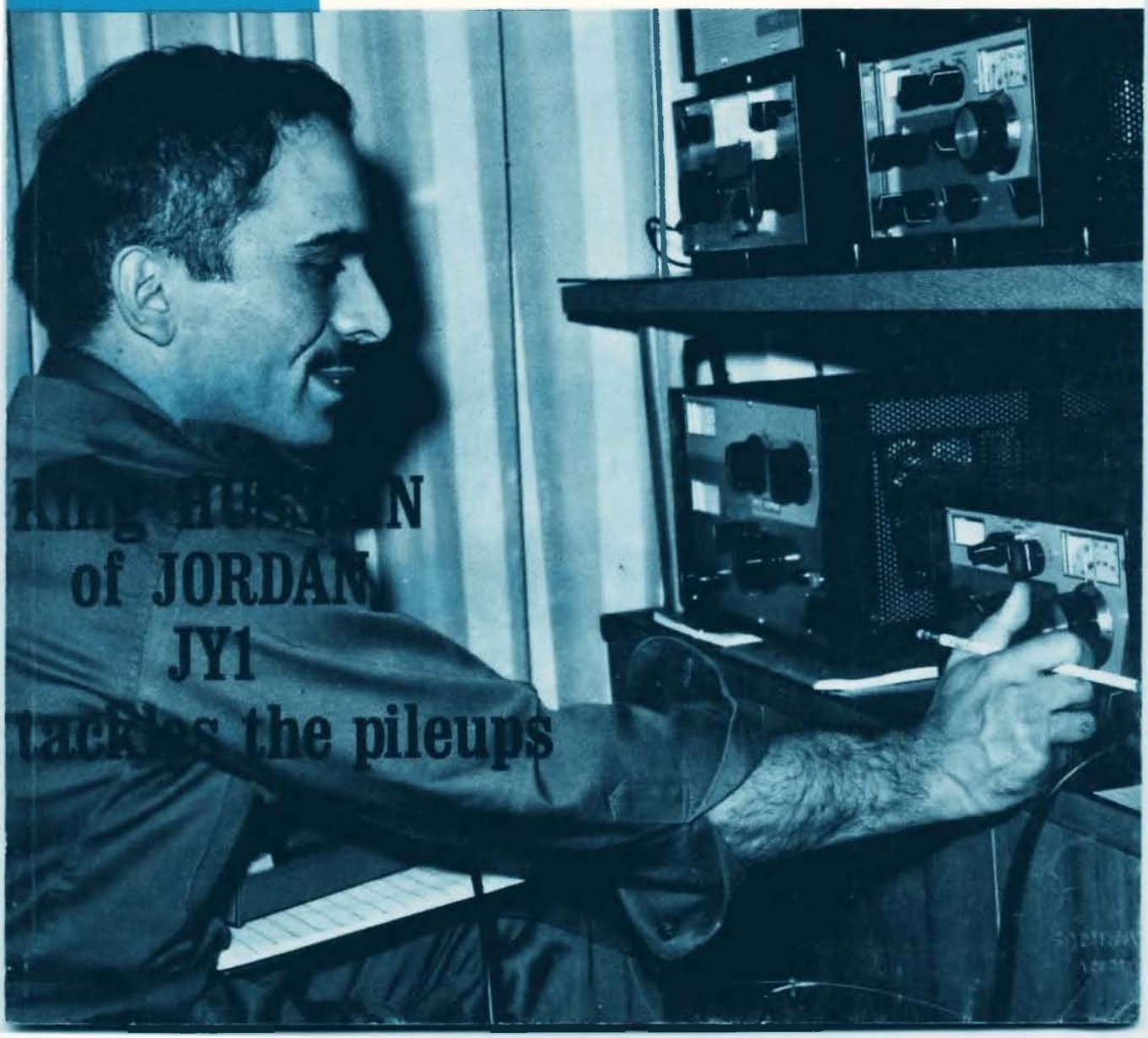
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73 MAGAZINE

#117 June, 1970

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Amateur Radio News Page

June XIXLXX | Monthly Ham News of the World | 73 Magazine

GOLDWATER PRESENTS HAM AWARD

Winner Flown to K7UGA Residence by Helicopter

by Bob Dreste K7VOR

Over the past seven or eight years, John Buchanan, a Tucson ham VHF-FM radio operator, has helped other amateurs repair their sets, taught them the tricks of the trade. He recently set up an amateur repeating station for FM at the top of Mt. Lemmon.

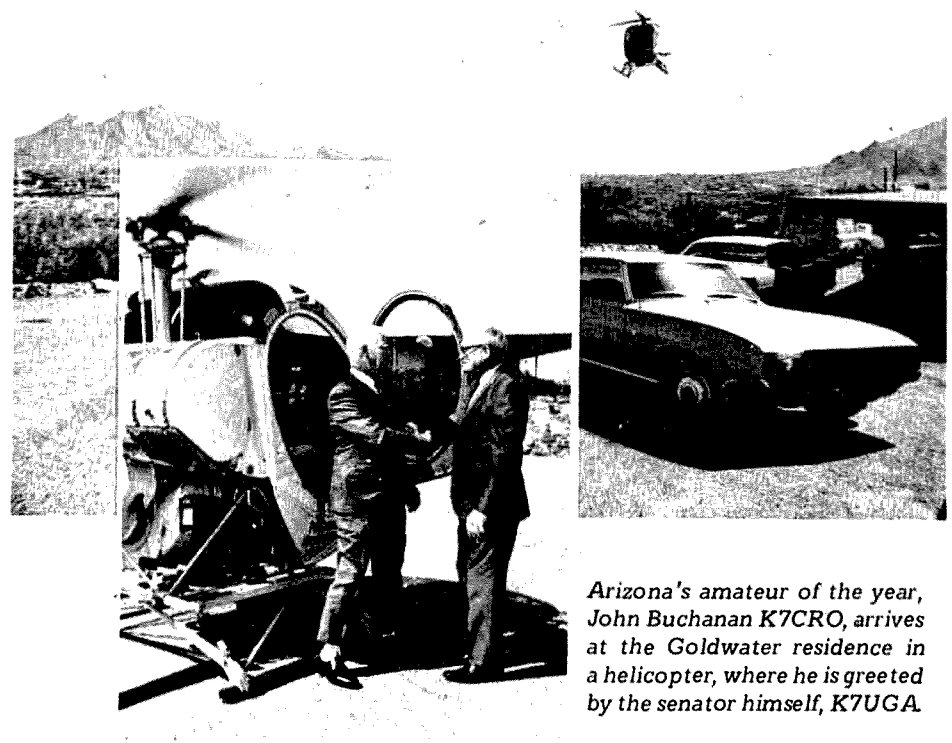
So when, for the first time, a state VHF-FM "Amateur of the Year Award" was given this year, it wasn't too surprising that Buchanan was the recipient.

He was flown by helicopter Thursday to the home of Sen. Barry Goldwater, in Phoenix, where he was presented a plaque for his research and activities in the VHF-FM ham frequencies.

More important, he was also given a solid state Varitronics IC2F, one of the newest instruments on the ham radio market.

The radio is symbolic, in a way, since Buchanan's latest project involved designing a new concept of a repeater station which would be all "solid state."

The concept itself is not new, Buchanan said, because it has been used for some time by commercial FM



Arizona's amateur of the year, John Buchanan K7CRO, arrives at the Goldwater residence in a helicopter, where he is greeted by the senator himself, K7UGA.

SPRING BRINGS RASH OF HAM TRAGEDIES

by W6KGN

In Costa Mesa, California, 20-year-old Laurence Bandiera (call not known) was electrocuted when the antenna he was erecting fell against a high-power line. Policemen who were called to the scene said that Bandiera's neighbor, Merrit Girgis, was helping with the antenna when it began to topple. Bandiera, Girgis told police, tried to hold the antenna as it fell against the wires. Attempts to revive Bandiera were futile.

Word-of-mouth reports from sales personnel at Radio Products Sales Co. in Los Angeles indicate that two other hams were killed in a Southern California plane crash. According to the source, the two were overflying hilly terrain in the vicinity of Los Angeles to look for a 2 meter FM repeater site. The two FM'ers were Carl Sundstrom K6IYI and Clarence Emerson K6QIP. Unconfirmed reports indicated the two were operating on 2 meters FM at the time of the crash.

Amateur Radio Station Operates At International Standards Meeting

stations, but ham radio operators are just beginning to get into the field of FM.

Up until now, he said, FM equipment was too complicated for the amateur to build. Recently, however, FM equipment has come on the market, either as obsolete or surplus goods, and the noncommercial radio operators are able to obtain what they need.

Buchanan has been in ham radio for about 12 years, but it is still just a side hobby. His business, logically, is machines, and he owns the Buchanan Machine Co., 2550 N. 14th Ave. in Tucson.



The honored FM'er displays bronze plaque and Varitronics newly released IC2F 2 meter FM unit. FM'ers will recognize Bill Adams K7OED president of Varitronics, Inc. on the right; ALL hams should recognize Barry Goldwater, who presented the award.

HAM RADIO in U.S.S.R.

by WB2CGE

The Soviet Union has some of the world's most skilled amateur radio operators and builders. Credit for this goes partly to the Soviet government, which sets high licensing standards and offers surplus equipment, technical knowledge, and attractive rewards as incentives. Possibly no other government does as much for its hams.

Despite these encouragements, almost no mass-produced equipment designed especially for Soviet amateurs is available. Today the Soviet Union's amateurs number over 15,000, second only to the United States' 300,000. About 10% of Soviet hams are women.

In order to become a licensed amateur, Russians usually follow this procedure:

1. Complete a basic electronics course.
2. Join a club and take a test which licenses them to listen on the ham bands. They must be able to send and receive code at 10 wpm.
3. After at least six months of experience as an SWL, the Russian applicant is then able to take the third class test.
4. The third class test consists of a more difficult exam and 12 wpm code test. The schematic of a 10-watt rig must be drawn, and they must explain how it would be integrated, how frequency stability would be achieved, what kind of antenna would be used, and how it would be tuned. The third class certificate permits them to use 10 watts on 3.5–3.65 and 7–7.1 MHz, CW, and 28–29.7 MHz phone. Licenses are renewed only when the operator moves to another class.
5. The second class license is more difficult. When passed, Russian hams are permitted to run a maximum of 40 watts. They can operate CW on 3.5–3.65, 7–7.1, 14–14.35, 21–21.45, 28–29.7, 144–146, and 420–435 MHz. They can use phone on 10 meter frequencies. 160 meters is not open to Soviet hams, nor is 6 meters (which is taken by TV).
6. The difficult first class exam is similar to the extra class in the U.S. They must be able to send and receive code at 18 wpm, design transmitter and receiver circuits, and build and troubleshoot advanced transmitters and receivers. They can run 200 watts CW or phone on all bands available to second class operators.

RADIO SHACK AND ALLIED JOIN

Form Multimillion Dollar Retail Merchandising Firm

Allied Radio, one of the most popular sources of ham gear in years past, has just been acquired by Tandy Corporation, parent firm of the multi-outlet "Radio Shack." The result is a total chain of more than 700 electronics department stores in 48 states.

To kick off the new association, all Radio Shack stores will display Allied catalogs. In time, the individual stores are expected to stock a large percentage of Allied's 30,000-item line.

For the time being, all Allied stores will continue to operate under the Allied name, though such stores will begin stocking Radio Shack's exclusive lines, such as *Realistic*, *Archer*, and others.

On the surface at least, this appears to add up to a pretty good deal for the amateur radio operator, who has never had much trouble finding a Radio Shack store, but who frequently finds it difficult to find the ham gear items he needs. With Allied's ham gear line, and Radio Shack's merchandising centers, getting parts and supplies should be simplified considerably in the future.

A special amateur radio station will be operating from the Washington Hilton Hotel in Washington, D.C. from May 17 to 30 while more than 1400 delegates from 41 countries are assembled there for the 35th General Meeting of the International Electrotechnical Commission.

Special temporary authority has been granted by the Federal Communications Commission to operate the amateur radio station which will have the callsign WF3IEC.

The station will be installed in Suite 9101 of the hotel. It will be under the supervision of amateur operator Ed Redington whose callsign is W4ZM. Mr. Redington will be assisted by members of the Foundation for Amateur Radio.

The station is planning to be on a round-the-clock basis. Single sideband radio-telephony and radio-telegraphy will be used on all bands except 160 meters.

A special acknowledgment (QSL) card will be sent to all who contact WF3IEC. Confirmation cards may be sent to W3ZA, L.M. Rundlett, Engineering Dept., Electronic Industries Assoc., 2001 Eye St., N.W. Washington, D.C.

The International Electrotechnical Commission is the oldest international standards organization in the world. The Commission is meeting in the United States for the first time since 1954.

FIELDDAY-CONTESTS

The German Amateur Radio Club invites amateurs from all over the world to participate in the German Fieldday-Contests 1970.

These contests are mainly for portable operating outside the home, independent of the mains using only batteries or petrol-electric generating sets for power supplies. For complete details contact Norbert Meyer DJ7JC, DARC Fieldday-Manager, POB 1752, D-463 Bochum, Germany.

Auction/Hamfest
in Pennsylvania

"Second Sunday in June," Third Annual Hamfest of the Foothills Radio Club, Inc., of Greensburg, Pa., will be held in Wendel Park, Wendel, Pa., 3½ miles South of U.S. Route 30, Irwin, Pa. All activities under an enclosed pavilion, rain or shine. Snack Bar for lunch, registration only required for prizes and parking is free. Drawings, displays and the traditional "trunk-line" merchants. New this year – public ham hear auction and a Club Display Contest."

QSO Party

The White Sands Amateur Radio Station, K5WSP, will hold a QSO party on July 9, 1970. The QSO party will be held in conjunction with an "Armed Forces Day" open house at White Sands. K5WSP will send a special commemorative QSL card to all stations contacted during the QSO party. The proofs of the QSL card are completed and the final, full color, model will be going to the printers soon. The card depicts 25 years of progress in aerospace and nuclear research and development at White Sands Missile Range. There will be several rigs operating simultaneously in the General class phone bands and possibly one Novice class band.

HAMFEST
Six Meter Club of Chicago Inc.

The Six Meter Club of Chicago, Inc., will hold its 13th annual hamfest in Frankfort, Illinois, on Route 45, one mile north of Route 30, on August 2, 1970. We anticipate that at least 1200 licensed amateurs, members of their families, and others who share an interest in amateur radio will be present. Contributions such as electronic parts, kits, components, books, QSL cards, antennas, magazines, instruments, gift certificates, etc., will be gratefully appreciated. All contributors

Pittsburgh, Pa.

The 16th annual Breeze Shooters Hamfest will be held at White Swan Park near Pittsburgh PA on May 17, 1970. This event attracts over 1200 amateurs annually. For more information contact J.L. Burnett K3IXB, 608 Charlotte Drive, Pittsburgh PA 15236.

ROME HAMFEST

The Rome Radio Club is holding its annual Ham Family Day on June 7, 1970 at Beck's Grove, Blossvale, New York. There will be three programs running simultaneously; one for hams . . .one for the ladies. . .and one for the children. The Hamfest starts at 1300 and at 1700 a steak and chicken dinner will be served.

WASHINGTON HAMFEST
Two-Day Program

by W7BUN

The Washington State Hamfest will be July 11 and 12 this year. This event will be sponsored by the Radio Club of Tacoma and will be held at the Sportsmen's Chateau, 164th and Canyon Road, south of Tacoma. Activities include CW awards program, QLF and QAS contests, mobile judging and mobile efficiency contests, technical meetings, technical displays, QCWA display, manufacturers' displays, 75 and 10 meter mobile hunts, swap shop, hole-in-one contest, women's and childrens' activities, after-dinner program, many fine prizes, etc. Camping space available on the grounds, $1.00 per night with free electrical hookup; 3970 kHz, 50.5 MHz, and 146.76 MHz FM will be monitored for arriving mobiles. The fee of $5 includes Saturday evening dinner and registration

ZL SSTV OK!

The Wireless Institute of Australia reports that slow scan or narrowband TV has been approved by the Postmaster General for use on all amateur bands as presently authorized in Australia.

Standards to be used are entirely at the discretion of the amateur, although bandwidth of emissions shall not exceed that of an A3 single sideband or double sideband signal.

Where A3 and A5 emissions are used simultaneously on the same carrier frequency, the total bandwidth is restricted to no more than that of an A3 double sideband emission.

Identification is required to be by call sign in visual form on televised picture and by telegraphy on telephony sound channel.

EBRC Spring Picnic

Saturday, May 2 at NAPA Valley Ranch Club, is the date and place for the spring picnic. The activities will include operating, archery, hiking, possibly swimming, ball games, etc., Guaranteed sunshine! There will be a nominal charge per person. Bring your own food.

ATLANTA HAMFEST

The Atlanta Radio Club will hold its 44th annual hamfest June 13th and 14th at the North DeKalb Shopping Center. The main prize is a Swan 500C transceiver with ac supply, along with many others. There will be many contests for the amateurs as well as games and other activities for the ladies. Further information may be obtained from John Fearon, 3384 Peachtree Rd., N.E., Suite 705, Atlanta, Ga., Tel. 261-4924.

News, Reviews, Announcements

Hawaii SCM to QSL for Kure
Notes 1969 Log Entries Not Valid

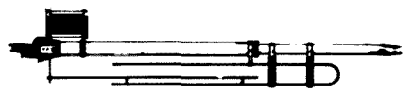
Lee R. Wical KH6BZF has announced that he is managing the QSL end of the DX business for KH6EDY, Kure Island, and that he holds that operating logs dating all the way back to January 1961.

In his report, Wical noted that some of the 1969 operations appeared to be invalid. The logs, he said were not, in all cases, properly signed in accordance with Section 97 of the FCC Rules and Regulations. He held hope for nonconfirmed contacts, however, by adding that QSLs for these occasions would be "handled on a case-by-case basis."

Wical listed the criteria to be met for stations expecting DX credit for Kure: U.S. amateurs must include SASEs; bureau cards will not be accepted. Do not send cards direct to Kure, as loss will be an inevitable result. DX stations must include SAE plus two IRCs for surface mail (or four IRCs for airmail).

Attachment Adds New Band to 4-Band Vertical

Mosley Electronics is marketing a conversion kit that includes a coil used to expand the Mosley 4-band vertical antenna to 5 bands. The added band,



will be publicized during the hamfest drawing, and in our Club's monthly newspaper "The Halo." Please contact Jack Hellwig K9ZWU, Prize Chairman, Six Meter Club of Chicago, Inc., 3420 S. 60th Court, Cicero IL 60650.

FERMANAGH FESTIVAL

Activates GB3

by Sean MacMahon G18AWF

For the second year running an amateur radio station will be established for the duration and in conjunction with the 1970 Fermanagh Festival.

The station, GB3FRE, will be in action at the Townhall Enniskillen, from Friday, June 19 to Sunday, June 28. At least two fully equipped operating positions will be set up. Operating time, which will be mainly in the evenings, will be spent most of the time on 160, 20, and 15 meters, sideband and CW.

The principal objects of GB3FRE, are:

(I) To enable hams throughout the world to have a contact with this rare county.
(II) To publicize Fermanagh.
(III) To interest members of the public in Fermanagh and elsewhere in amateur radio.

A special QSL card will be issued to all stations from whom a QSL is received.

Last year GB3FRE was in great demand and worked approximately 800 stations in all continents.

20 Meters

All stations having traffic for the L.A. area are invited to check into the Southern California Amateur Network, 14.325 MHz, 0500–0600 GMT, Monday thru Friday.

(Children under 12, $1.50 for dinner only). Logger's breakfast served by the club Sunday for only $1.25. Snack bar open both days. All dinner reservations must be made in advance. Contact John Austin K7CZF, 8478 Eastside Drive N.E., Tacoma, Washington 98422, for information, motel reservations, or hamfest tickets.

Champlain Valley Hamfest

The annual hamfest of the Champlain Valley Amateur Radio Club will be held July 19 starting at 10:30 a.m. at the club shack on Akey Road, Cadyville, N.Y. (7.2 miles west of Plattsburgh on Route 3.) Food and beverages available on the grounds, talk-in on 146.34-146.94 FM (W1KOO) and 3925 Kc. SSB. Send advance registrations ($1.50) to CVARC, Box 241, Cadyville, N.Y. 12918.

ERIE, PA. BANQUET

On Saturday, October 10, 1970, the Radio Association of Erie will be holding its annual dinner banquet. This is our 25th year of serving the ham and community, having been founded in 1945. A part of our program features the giving away of door prizes which are donated by local stores, as well as various gear from manufacturers and distributors. The Radio Association of Erie would be honored to have companies represented at our dinner and W3GV would be happy to distribute the literature and will provide advertisement in our monthly paper, the *QUA–RAE* in return for any donation. Please send any donated material to: The Radio Association of Erie, c/o John Gebler, PO 844, Erie PA 16512.



Charles Ercolino Named Telrex President

C. Charles Ercolino has been elected president of Telrex Communication Engineering Laboratories, Asbury Park, New Jersey, manufacturers of TV and communications antennas. He succeeds his father "Mike" Ercolino who will continue as chairman of the board and chief engineer.

Charles Ercolino is a graduate of Youngstown University with a BS in business management. He started with Telrex as a salesman traveling the country extensively.

In discussing this change in leadership, Mike Ercolino said, "The time has come for Telrex to expand both its TV antenna line and its communication antenna systems. To do this, we need the vitality and modern marketing methods which stem from younger people. I look forward to being able to devote my time to research and development as well as supervising the construction and installation of our 'Big Berthas' and other highly sophisticated arrays for which Telrex is noted. I have enjoyed every minute since we established Telrex nearly fifty years ago. Now it's Chuck's turn and I know he'll do a good job."

75/80 meters, is incorporated with a special coil rated at 2000 watts PEP that attaches to a condenser tube fitted over the vertical element of the original vertical (RV4C). Tuning is accomplished by sliding a U-shaped matching rod along the vertical element until the desired frequency is attained. According to Mosley spokesmen, the resultant vswr is 1.5:1 or better.

VHF'ers PICNIC

The Mt. Pleasant Amateur Radio Club cordially invites you to attend the southeastern Iowa VHF'ers picnic to be held at McMillen Park, Mt. Pleasant, Sunday, July 12, 1970 from 9 a.m. Pot Luck lunch, free coffee, trunk sales. All hams welcome, no charge. Rain or shine, shelter provided. Talk-in on 50.480 and 3.950 MHz.

Lancaster and Fairfield County Hamfest

The Lancaster and Fairfield County Amateur Radio Club is pleased to announce their annual hamfest to be held this year at the Lancaster Fair Grounds in Lancaster, Ohio, Sunday May 31, 1970. The club will be happy to accept any prize contributions, large or small, for use as door prizes. If further information is required, please write for reply to Howard Schaefer, President, The Lancaster and Fairfield County Amateur Radio Club, P.O. Box 3, Lancaster OH.

Massachusetts Amateur Radio Week

Worked all Massachusetts cities & towns

These two contests under the auspices of the Massachusetts Chapter of the National Awards Hunters Club will take place the week of June 14-20 from 0001 GMT June 14 to 2400 GMT June 20. These will run simultaneously during this week which has been proclaimed by the Governor as Massachusetts Amateur Radio Week.

Editorials

Dayton Hamvention A Real Blockbuster

by K6MVH

The Dayton Hamvention was the biggest smash success of any ham convention I've ever seen. Records showed that more than 4000 hams passed through the halls at Hara arena in Dayton to see the wares being exhibited by the manufacturers. The flea market area, where hams from all over the country displayed their goods for sale and trade, covered a seemingly endless territory from the arena proper to a dirt area a jillion miles from the buildings. Money changed hands faster and more furiously than in a Las Vegas casino, and many hams bought and sold to such an extent that they were able to run up a modest purchase into an impressive shackful of equipment.

The convention area was several miles from the nearest hotel, which might have presented a problem for many out-of-staters who flew in for the occasion. Anticipating such logistical dilemmas, the Hamvention planners hired buses that ran regular schedules during the convention. The distributors themselves, however, with their heavy displays and other exhibit material, found themselves in a veritable "transportation bind."

The 73 booth was so active that all the magazines and books I had taken were gone the first night of the Hamvention. If I couldn't get more from Peterborough I would have been out of business. A quick long distance call got more books loaded onto an airplane, but there was still the problem of getting the merchandise from the Dayton airport to the arena.

Thanks to the traditional ham spirit, as exemplified by Steve Holden

FREE SPEECH for HAMS?

by K2AGZ

If you read the May issue of 73, and I hope you did. . .and if you happened to see the lead story in the recently inaugurated Radio News Page, and I would be disappointed if you hadn't. . .you are aware that we may witness, eventually, some sort of court test of FCC Rule 95.83(a) (3). This rule spells out prohibitions of ". . . obscene, indecent or profane language, words or meaning." Commissioner Nicholas Johnson, in a detailed statement, which the Commission published as an appendix to Docket 18804, expresses serious reservations as to the constitutionality of 95.83(a) (3), due to an apparent abridgment of the guarantee of free speech, as explicitly cited in the First Amendment, part of the Bill of Rights.

This matter is of particular significance to amateurs because of the dialog which followed a specific editorial in QST, in which it was stated by inference that the FCC did indeed have the right to suspend or revoke ham licenses on these specific grounds, and in which the editorial took the position that free speech, while it may be guaranteed in all other respects in our society, may be undesireable on the ham bands. 73 disagreed with QST's position, as expressed in Leaky Lines. And the correspondence which was subsequently published in QST showed that there was disagreement among rank and file ARRL members also. In its editorial, QST also sanctioned the activities of a group of self-appointed monitors and vigilantes, who constantly roam the bands, gratuitously offering opinions and advice in the form of unsolicited and unwelcome anonymous comment as to the appropriateness or acceptability of other people's conversation. They were sanctioned thus, entire text of Johnson's statement. We urge you to refer to page 2 of the May issue of 73, for the text. Although it is merely an opinion, it is certain that it reflects the views of a growing body of persons with profound misgivings with respect to an apparent drift of public confidence away from the Bill of Rights. A growth of willingness among the public to repeal such guarantees, all of which are fundamental to our system, makes it particularly important to focus attention upon the dangers of a too equanimous approach.

This is a deadly serious matter, and merits the undivided attention of every American who values our way of life, for if ever we allow these time-tested cornerstones of our Constitution to be eliminated, we would be opening the door to the most heinous form of totalitarian tyranny. . .that of mob rule!

At this juncture, I can almost fancy that I hear the voices of some of my best friends, even, saying that I'm going crazy, for how could anything so unimportant as this possibly result in any type of totalitarian takeover.

So that there may be no ambiguity about this point, let me enlarge upon it and examine it. The Bill of Rights, basic threads in the fabric of our democracy, came about as a result of the experiences of other nations where no guarantees existed. Indeed, they were unique because they had never been embodied in any *corpus juris* prior to their adoption here, in our Constitution. This was a new experiment; untried and unheard of. There was but one purpose in them; to guarantee the rights of all citizens who might hold minority views at variance with the views of the majority. If you study them, you will find this implicit proved ability to tolerate all sorts of differences of opinion. We do not require the sort of conformity which would guarantee our leaders a type of authority minus checks, balances, or criticism. Our country is the best on earth because of this apparent contradiction; not in spite of it! And when we forsake this fundamental principle, that is the day we will begin to deteriorate into something less than the best.

The drive toward conformity of ideas, ethics, morals, dress, manners, standards, and goals, is fraught with the most fearful consequences. The most alarming result of all this is the seeming docility with which many persons are accepting the idea. We are growing so used to having the government rule every facet of our lives these days, we are beginning to lose our ability to think like free men. If we do not put a stop to it, we may be getting close to the adoption of the "Big Brother" system. (*Ed. note: 1984 is less than 14 years away!*) That would be the end of our free society.

Commissioner Johnson recognizes this. When we go on the air and voice opinions, no matter how distasteful they may seem to some, we are guaranteed the right to express them, as spelled out in the Amendment. Until there is devised a meaningful set of standards which will clearly delineate the limits in unmistakable and unequivocal terms, then no one has the right to muzzle us. . .not the FCC, the Vice President, the attorney general, or even some self-righteous hams, who appoint themselves the sentinels of public morality.

The Constitution was never meant to provide anyone with a guarantee against somebody else's freedoms to

K8RZL, the problem wasn't one after all. Steve, the trustee of Toledo's FM repeater, not only made the trips to and from the Dayton airport, but he made his services available to 73 on a no-strings basis throughout the whole convention.

It is sometimes difficult to determine what makes one show such a phenomenal success and others no more than adequate. Looking back and analyzing the convention objectively, I can see several factors that might be key contributors to Dayton's popularity. Other convention planners take notice:

Plenty of active on-the-air exposure, with continuously manned talk-in frequencies.

Carefully planned and well executed advance advertising and coordination, including interesting publicity releases.

Saturated publicity around Dayton. Motels carried special "welcome" signs, a Foster & Kleiser billboard screamed out the Hamvention message, and special buses sported huge banners giving the essentials.

An atmosphere of friendliness pervaded the arena. This is extremely important, and was handled professionally and proficiently by the Dayton Hamvention people. In many conventions, you get the feeling everyone is after your money – but not at Dayton. The local amateurs, for example, set up a coffee and donut area the first night, right on the convention floor; a large sign told the world the goodies were free. And there was plenty of refreshments to go around.

Local amateurs participated in the convention, giving the impression that they really cared about how the attendees felt. K8RZL's support to 73 was but one example among many.

The ham booths were taken seriously, carefully prepared, continuously manned, and were not "junky" in appearance. The FM booth, in particular, was a winner. The clever local FM group which operates on the local repeater output frequency of "seven-six," managed to get some advertising gimmicks from Union Oil Co.'s "76" gasoline promotion campaign. They were able to display a huge orange ball with a boldly imprinted "76" in the booth, and distributed smaller versions of the balls to local FM'ers, who fixed them to the tops of their handie-talkie antennas.

The safest way to assure a successful ham convention, it would seem, is to plan all activities, promotions, meetings, and logistics well in advance, and to treat all attendees with as much respect as you'd show your own relatives. And after all, aren't we all related anyway?

despite the fact that they, the vigilantes, are in clear violation of a totally unambiguous rule pertaining to station identification.

It now appears that there are serious doubts, not only with respect to the previously condemned use of prohibited styles of language, but also concerning the very rule which spells out such prohibition. We have always contended that since there are no precise standards for permissible speech over the air, and that those standards which do exist merely reflect an arbitrary individual point of view, depending upon the criteria of the party in judgment, then it is clearly an abridgment of individual liberty when speech is limited, so long as such limits are not in conflict with what is clearly against the Constitution, as in cases of sedition or treason, as spelled out in the Smith Act, for example.

We cannot, of course, reprint the

in each and every one of the Amendments of the Bill of Rights. The First assures freedom of speech, press, and the right to petition for redress of grievances. It also guarantees against laws respecting an establishment of religion, or prohibiting the free exercise thereof. This is clearly designed to protect the rights of minority opinion. And the others are similarly designed, whether the Fifth, which protects against self-incrimination; the Seventh, which guarantees trial by jury; the Fourth, which prevents unreasonable search and seizure, or any of the others. They were created explicitly to protect those who might hold minority views, and to protect their right *to express* those views.

There happens to be, however, a very strong current running just now, encouraged by powerful persons, including the Vice President, which opposes the spirit of these Amendments. Mr. Agnew keeps talking about the will of the "silent majority," and about the "liberal press which thwarts that will," and about "intellectual punks." He has been extremely vocal in his attempt to stir up public outrage against those persons and groups representing views which differ from the norm. A recent poll by CBS-TV disclosed that many people are now expressing willingness to repeal all or part of the Bill of Rights, and one cannot separate this growing willingness from the context of the Agnew statements and others. Consequently, the end result would be a stifling of all but majority opinion and majority will. . .clearly an example of the precise condition which the Bill of Rights was designed to avoid.

It must be stated here that I do not presume to tell the Vice President of the United States that he is wrong and I am right. I do not disrespect Mr. Agnew; I regard him as an articulate, capable spokesman for a point of view with which I happen to disagree, that is all. One thing I know. . .the strength of this nation is based largely upon our speak or think. Your freedom depends upon mine. And when I lose my freedom of speech, you begin to lose yours.

So where does all this leave us? It simply means that we come down to the same old standards we've always observed; common sense, good taste and tact. Speech cannot be legislated. Neither can feelings, instincts, ideas, thoughts, or tastes. Just as you cannot regulate prejudice by statute, you cannot impose a state of verbal unanimity. Goodwill can be found not in a law book, but in the human heart.

The point is, though, that when someone doesn't quite measure up to your idea and mine of what constitutes proper behavior, it may not be within the Constitutional rights of the FCC to deprive him of his license. This is the tenor of Commissioner Johnson's statement. If this view should be upheld in a court of law, it is likely to cause a great deal of change in ham radio.

But once again, we can recognize the deep need for a rewriting of the FCC regulations. This one ambiguity, resulting from the confusing language of the regulations, is like the proverbial one-eighth of the iceberg which is visible.

INDIANA HAMFEST

The Madison County (Indiana) Amateur Radio Club will hold its annual "Hamboree" on Sunday, July 12, 1970. Doors will open at 11 a.m. at the county Civil Defense Control Center located 4 miles north of Anderson at Linwood. Activities include a general get-together and flea market. Door prizes will be awarded thru the afternoon, and refreshments will be available. Talk-in freqs. 50.4, 145.35, 146.940.

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"TOWER HEADQUARTERS!" 12 brands! Heights aluminum 35% off! Antennas—20% off! Galaxy, Hammarlund, Gonset, SBE at discount. Catalog—20¢. Brownville Sales Co., Stanley WI 54768.

40th ARRL WEST GULF DIVISION CONVENTION July 17, 18—19, Orange, Texas. Come by car, plane, or boat, but come to the fun, fellowship and entertainment. A bargain you can't afford to miss. Registration, $8.50. Orange Amateur Radio Club, Box 232, Orange TX 77630.

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TRANSISTOR PROJECTS: send for free list. EDI, 1918A 49th St. E. Palmetto FL 33561.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd PA 19004.

NOVICE CRYSTALS: 40-15M $1.33, 80M $1.83. Free flyer. Nat Stinnette Electronics. Umatilla FL 32784.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland CA 94610.

END CARD PROBLEMS. Frame, protect, store or display 200 QSL's in 20 card plastic holders for $3.00, prepaid and guaranteed. TEPABCO, Box 198, Gallatin TN 37066.

FM MOBILE/PORTABLE TRANSCEIVER, 2 meters. Varitronics FDFM2. Perfect for repeaters. Six crystal-controlled channels included: .34—.94, .94—.94, .34—.76, .31—.88, .22—.94, .28—.76. Crystals are International. Includes 12V battery pack, mobile battery cable w/connector, $200. Ken Sessions K6MVH, RFD 2, Peterborough NH 03458.

HEATHKIT DX60-B, $70. Johnson electronic T-R switch, $25. Both for $90. College forces sale, good condition. Chuck Logan WAQURY, P.O. Box 694, Moville IA 51039.

BECKMAN Freq Cntr & conv. (7370—7570) 0-1 GHZ, Mint, $450. SP-600-J, $195. EICO 753, $95. B.N. Adams, 125 Cordova, Alhambra CA. Tel. 576-1025.

BEFORE YOU BUY any balun, see page 79 for the new higher power balun, all stainless steel hardware. Unadilla Products, Dept. I, Unadilla NY 13849.

1970 S.E. WISCONSIN SWAPFEST July 18. Sponsored by South Milwaukee Amateur Radio Club. Write Larry Kieck K9ZBX, 2801-9th Ave., So. Milwaukee WI 53172.

DTL INTEGRATED CIRCUITS: Guaranteed new-gates 70¢, buffers 80¢, F/F 90¢, dual F/F $1.15. Add 20¢ postage. Also other inexpensive parts. Lists and prices from Mitch-Lan Electronics Co., Dept. 770, P.O. Box 4822, Panorama City CA 91402.

HQ 110-C Hammerlund Recvr with clock and 100 KC calibrator and manual. Model B Central Electronics sideband-slicer complete with AP-1 (IF amplifier stage) Q multipler and manuals. Audio filter used with above items. ALL for $110. W2KKA, P.O. Box 85, Nicholville NY.

HAS ANY ONE built a transistorized single band 80 meter SSB transmitter using switchable modules of Davco DR30 receiver? Please state your price for diagram. S. Renaamo, 4318 Sixth Avenue, Tacoma WA 98406.

LZ1KSZ desperately needs an i-f filter, any frequency, for his homemade SSB rig. 5 MHz ideal. If you have one to spare please send it to 73 Magazine or direct to LZ1KSZ, Box 73, Stara Zagora, Bulgaria marked as a "free gift, used radio part, no commercial value."

COLLINS MINT KWS1: $500, BC221, P/S $50. New RBU 2 Panadapter $50. RCA 7 inch Scope $35. Send SASE for list. Need Collins Mechanical Filters. Write 73 Magazine (Box 60) Peterborough NH 03458.

MINT CONDITION! HQ 160 General coverage receiver, matching speaker and owner's manual. First $125 takes. W6VDA, 4850 Jessie Ave., La Mesa CA 92041 (714) 466-3129.

2 PORTABLE TRANSCEIVERS, Wabco 14H82C, 148—174 MHz., FM, 2 Channels, Input 10—18 VDC, 3W RF output, 0.5 W audio output, 14 diodes, 30 transistors, triple conversion receiver, like new with manual, $225.00 each. B. Dickerson, 1200 Johnston St., Phila PA 19148.

TONE DECODERS: Touchtone-Digital-Burst. Solid-state, modular, plug-in unit, 2 x 2 x 3 in., $22.50 postpaid. ITT 12-button tone dial, $27.50. Write Digitone, Box 116, Portsmouth OH 45662.

HOSS TRADER ED MOORY says he will not be undersold on Cash Deals! Shop around for your best cash price and then call or write the HOSS before you buy! Ed Moory Wholesale Radio Co., Box 506, Dewitt AR 72042. Tel. 501-946-2820.

WISCONSIN HAM PICNIC

The Wisconsin amateur radio picnic, sponsored by the Wisconsin Nets Association will be held in Oschner Park in Baraboo, Wisconsin on July 12, 1970. Activities will include code receiving contest, softball game, ladies' activities & eyeball QSOs. Refreshments are included with registration but bring your own lunch. Registration begins at 10 a.m. Registration is $1.50 single, or $2.50 for family.

information, write DIGITONE, Box 116-S, Portsmouth OH 45662.

FOR SALE: Heath SB200 linear w/manual. Only 10 hours use. Excellent condition. $190.00. W1MCO, 130 Main St., Marlborough NH 03455.

STROBE LIGHT PARTS: Flashtube (FT-151) 125 watt-seconds, matching triggering coil, reflector, suggested schematics. $15.95 ppd. CLAUDE'S Surplus Electronics, 621 18th Ave., Belmar NJ 07719.

WANTED: Hammarlund Model HX-50 with 160 mtrs, in good condition. Peter Turbide K1VGR, 42 Washington St., Newburyport MA 01950.

WORLD RADIO'S used gear has trial-guarantee-terms! 22er—$129.95; 66'er—$99.95; 99'er—$69.95; KWM2A—$749.95; 350 late—$289.95; 400 & 420 VFO—$279.95; NCX3—$159.95; Galaxy V—$229.95; HT40—$49.95; 75A1—$149.95; 2A—$159.95; R4—$299.95. Free "Blue-Book" list for more. 3415 W Broadway, Council Bluffs IA 51501.

COLOR ORGAN KIT, three 200 watt channels, $7.50. Cabinet, $8.50. Power supplies, $2.75 to $8.50. Ceramic capacitors, $.10. Dual flasher 1000 watt, $3.98. Computer grade electrolytic capacitors, $.35. TV cheater cords, $.25. Catalog. Murphy, 204 Roslyn Ave., Carle Place NY 11514.

FM RECEIVER. Portable, Heathkit, tunable, model GR-88. Tunes from 145 to 167 MHz. Battery-operated. Exc. sensitivity and selectivity for monitoring local repeater outputs. Like new, $50. Ken Sessions K6MVH, RFD 2, Peterborough NH 03458.

FM MOBILE TRANSCEIVER, 450 MHz, 2-channel trunk mount RCA rig in perfect condition. Fully duplexed and operating as a mobile telephone. Includes transmit crystals for 442.12 and 442.05; receive crystals for 448.82 and 448.85. Crystals are from Sentry and all enclosed in ovens. Complete less control head and cables: $100. Will throw in two 4 dB Com Prod mobile gain antennas. Ken Sessions K6MVH, RFD 2, Peterborough NH 03458.

GREENE... center dipole insulator with...or...without balun. See 73, November '69, page 107.

FOR SALE: HW 32A mint condition, $75.00. Heathkit IM—17 VOM, $12.00. Max Holland, W4MEA, Hiwassee College, Madisonville TN 37354.

SELL: HT-37, mint condition $200 (can deliver St. Louis). EZ Way crank up tower with H.B. rotator, house mount $90. William M. Hurni, 1204 Inverlieth Rd., Lake Forest IL 60045.

AM PARALIZED bedridden, multiple sclerosis. Cannot afford correspondence course, TV repair. Please lend me yours. Technician Tom WB4CBV, 504 Victoria Blvd., Auburndale FL 33823.

TRADE: 28KSR, 19, Typing reperforator, TT/L-3, for 28ASR, 60 cycle supply or motor for mite. David G. Flinn, 10 Graham Road West, Ithaca NY 14850.

LINEAR BUILDERS: Send SASE for amplifier and power supply parts. Low price list. "Fox" 2006 West Gonzalez St., Pensacola FL 32501.

WANTED: Up-to-date roll chart for "Precision" Tube Master, series 10—12 tube tester. WA5QFV, Route 2, Box 82, Bowie TX.

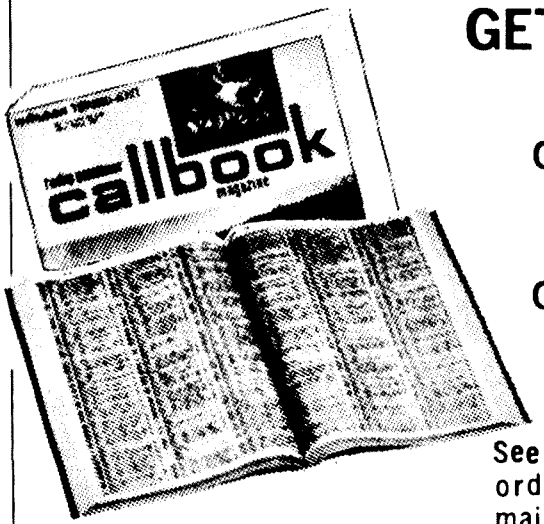
NEW ROHN 50 ft. Foldover tower prepaid, $199.95: New Mosley Classic 33 and Demo Ham-M Rotor, $138.00. Ed Moory Wholesale Radio Co., Box 506, Dewitt AR 72042. Tel. 501-946-2820.

USED EQUIPMENT: R4, $269.00, HT-37, $179.00, 75A-4, $299.00, 2B, $169.00, Galaxy 5, $229.00. Ed Moory Wholesale Radio Co., Box 506, Dewitt AR 72042. Tel. 501-946-2820.

FOR SALE: COD HW32, EICO753, HQ100, SX100, DX100, $100. BC348, BC221, TBS50 $75. DX40, DX60, HT40, $60. Globe 90 $30. F. Shain, Box 8352, Savannah GA 31402.

HW-12, factory overhauled, HP-23, PTT mike. $105. WA4LBO, U-2255, Columbia SC 29208.

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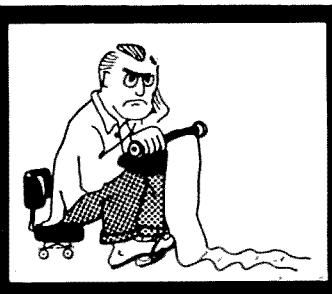
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EDITORIAL BY WAYNE GREEN

A Visit to Jordan

With nothing more to go on than a note in Gus' DX bulletin to the effect that King Hussein of Jordan had been heard on the bands fighting off tremendous piles of QRM, I sent a cable to him asking if he could use some help for a few days to beat down the multitudes. With Radio Today just being started and the tight U.S. economy making its pinch felt all too clearly on 73, I wasn't really too enthusiastic about my proposal.

On the other hand, the insurmountable problems at 73 have continued without any real letup for a long time, with me there or away, so perhaps a few days off wouldn't be too serious. And uppermost in my mind was the opportunity to possibly make a good friend for amateur radio, one who could have a strong long-range impact on the hobby. If amateur radio could be developed in the Arab countries this would not only benefit them tremendously by encouraging the growth of engineers and technicians, but would help amateur radio by giving it a few more votes at the ITU conferences in the future.

Much to my surprise an answering cable arrived from His Majesty asking me to come. Within a few days I was off to Jordan and whatever lay ahead. Where would the station be? At an army base? Perhaps in the palace? Would I be able to operate much? Would I get to do more than just meet His Majesty? Those of you who have been reading my editorials know that all sorts of ingenious plans for solving the mid-East crisis started coming to my mind.

When I checked in at the airport in Boston they suggested that I hand carry all films with me since all checked baggage is xrayed at London before going on to the mid-East. This called for a complete repacking of my bags in the black of the parking lot, and I ended up by carrying on two bulky bags full of cameras and film.

Lin didn't think I should go in my dungarees, so I hope the IRS will agree that the business suit I bought for the trip was a necessary business expense. You don't need business suits very much in New Hampshire.

The plane left Boston in the evening and arrived in London the next morning. As usual on these trips I managed zero sleep. They had some fool movie that I had seen so I saved the $3 for the earphones, but still couldn't keep my eyes off it.

After a couple of hours wait at London in the passenger lounge I was off again to Beirut. I'd written Bob OD5BZ there, hoping he would have time for dinner between my planes. Late that afternoon I arrived at Beirut, but no Bob. I found out later that he was out of the country on business. I put away a great Arabian meal at the airport restaurant and continued on to Amman on a Royal Jordanian Airline plane, landing there about 9:30, wide awake on my second wind, beyond being tired.

There was a big commotion outside of the plane, with newsreel photographers and all ... the man beside me said, "Look out there and see our King." Sure enough! I could end that there, leaving you with the notion that he had come to see me, but actually he was greeting his sister. I was met by a man from the palace who expedited my passport and bags through, told the King that I had arrived, and drove me in a beautiful Mercedes to the Jordan Intercontinental Hotel where I was to be the guest of His Majesty!

I slept.

The Hotel Jordan, as it is called, is an American style hotel ... showers, wall-to-wall carpeting, the whole bit. It has a serviceable coffee shop and a first rate restaurant on the roof. The "maids" are men, but they know all the ropes such as opening your door at 6 a.m. to see if the room is occupied. Just like America. They try the door again at 7 to make sure they were right at 6.

The next morning a phone call explained that a Mrs. Salti would be picking me up shortly. Mrs. Salti turned out to be the private secretary to His Majesty and a very nice looking English girl. She explained that there was some sort of big do on shortly if I would like to come ... I grabbed my camera case and we were Mercedes'd to the gigantic sports arena ... jammed with people. We sat up in the grandstand, not far from the King's box and awaited developments.

The "do" consisted of a couple hours of speeches, His Majesty presenting flags to a number of artillery groups, inspection, parades, and some really beautiful precision marching by both military and bagpipe bands. There were some-

what over 15,000 people in the stands for the big show.

Mrs. Salti delivered me back to the hotel and promised to pick me up later to meet His Majesty. She surprised me by arriving in her little Renault instead of a Mercedes and we were off to see the King.

We drove for some ten miles or more out of town, stopping at several checkpoints and gates along the way, ending at a beautiful two-story modern home atop a hill with a little vertical antenna on top. We were met at the door by His Majesty and shown into the study where he has his ham station. He has a Drake R4B, T4XB, L4, and MN2000 tuner. A nice setup.

During the next two weeks I operated the station using the call JY1 on a daily basis, usually operating from about 3 p.m. until 8 or 9 p.m. Since the station was installed in the King's home (palace) I appreciated that he and his family were not too anxious to have me sitting there around the clock. We did arrange for one all-night session in order to make JY1 available to the eastern U.S. stations who missed the 1300 GMT openings.

I had the opportunity to talk with His Majesty on many occasions, sometimes for an hour or so. I found him to be interesting, well informed, warm, friendly, and reasonable in every way. I in no way found an emotional and intransigent Arab leader. He is modest, rather shy, and gracious almost to a fault. The list of problems he has to face would fill a book . . . a lack of resources . . . shortage of water . . . lack of power facilities . . . extremist groups galore . . . little industrial capacity . . . undeveloped agriculture . . . recent loss of a large part of his people and the most productive and advanced territory (Palestine) . . . a loss of brainpower to more developed countries . . . a loss of money from the wealthy to safer banks in Switzerland. . .

Bleak as the picture might seem to be – and I should hasten to say that His Majesty offered no complaint, only optimism – the list above is one I gleaned from talking with others. He has accomplished miracles already, considering what he has to work with. The State Department paper on Jordan is most enthusiastic about the rapid strides that Jordan has made in the last few years since King Hussein came to power at 17 years of age in 1953.

One evening I was invited to dinner by His Majesty. Along about 10 I joined the family in the living room watching television. The children were off to bed much earlier (twin girls, two years old, and two boys about five and six). With His Majesty was his English wife and her parents, his sister and her husband, etc. Dinner was served and we went to the dining room. There was an oval glass-topped table about 12 ft long, just loaded with dishes of food in the center. We sat down and helped ourselves family-style to roast lamb, hamburger patties on rice, salad, cheese omelette, ad infinitum. For dessert, sweet fresh strawberries and whipped cream.

After dinner we all got in the cars and were off to the downtown palace for a movie in the King's private movie theater. The feature this night was billed as a comedy, but it was "If," and the imagination has to be stretched a lot to call that grim exercise a comedy. Mrs. Salti dropped me at the hotel at 2 a.m.

Well, so much for the royal life . . . now, what about the ham radio end of things? I did manage to get quite a few stations contacted, even with the time restrictions. I doubt if there are any stations in Europe with any serious interest in DX that have not contacted JY1. For that matter, there really should not be many stations around the world that missed working JY1, if they set their minds to it.

For the most part I found everyone most cooperative and helpful on the air. There were exceptions, of course, but they were exceptions. One of the biggest problems in this area is the wonderful propagation just about around the clock into Italy . . . or should I say from Italy into Jordan? Couple this with the absolute fact that somewhat over 90% of the Italian operators do not understand one single word of English and have no intention whatever of not making a contact exactly when they want to, no matter who else is involved or what they want. I am afraid that I am guilty of taking advantage of this once or twice, being quite insulting because I knew darned well that the offending station would not understand. For instance, only once during the entire two weeks at JY1 was I able to get through to my home station and actually hear them. All through this contact I1VEL continued to call almost continuously, ignoring the most pitiful pleas to wait. You might think that the best answer to this is to just sigh and go ahead and let him make his contact. This is probably so, but it is discouraging to know absolutely certainly that this chap is going to have a very long name which he will spell phonetically twice for you, followed by an even longer city name which he will also spell twice phonetically. Then he will demand to know my name and where to send the QSL card and will not be placated in any way until he gets this information spelled out phonetically twice. Since I had to go through this routine well over a hundred times I am absolutely certain that one of the worst enemies of our hobby yet to turn up has been licensing Italians and giving them a card with their contacts all spelled out for them. All they have to do is read from the card to make contacts and there is no need whatever to understand any English.

There are other devils to slay. While I found most of the USSR amateurs quite polite and cooperative, I must say that the bulk of the really rotten signals also came from their direction. They have a virtual monopoly on bad signals.

Most of the time I was quite successful in using the transceive system of operating. About

(continued on page 140)



I've been dying to talk about New England, and now that the boss is gone, there's no one to stop me. Wayne got an invitation to spend a few days with Jordan's King Hussein, and like a lightning flash he was gone. Now if I can get this editorial into print before he gets back, I'm home free.

The reason I wanted to talk about New England is because I am an impressed Californian. I was born in California and I lived there all my life. Like most other out-of-staters, I had heard a lot about New England, but nothing that would warrant making me want to go there for any length of time. But now I'm here and I'm hooked on the place. (Imagine – four different seasons every year!)

Now, I'm a ham and this is a ham magazine, so I don't suppose I'll be readily forgiven if I deviate from the track for any elaborate travelogs. But I feel like Wayne must have when he got his International Crystal Co. microwave oven – it's so great I *have* to talk about it. There's a whole new realness to American history when you live in New England. It's so easy to get all the behind-the-scenes facts.

Take Paul Revere, for instance. Now, it could be that California schools are a trifle uninformed when it comes to historical events that took place before the state was even a territory. And I might be basing my judgment on Longfellow's misleading "Midnight Ride" epic. But since I came to New England I have learned that old Paul was only one of several who spread the word about those consarned Redcoats. And he failed his main objective – to get word to the citizens of Concord that the King's "Regulars" were high-tailing it from Boston to confiscate or destroy supplies that the Provincials had stored in and around Concord.

Paul took off from Boston all right. He split as soon as he and his companion learned how the Regulars would be traveling. Just a jump and a half ahead of General Gage's troups, Revere and his companion, Dawes, went riding toward Concord. They stopped in Lexington with a message for upstarts Hancock and Adams (the Hoffmans and Seales of the day). Part of the British troops' assignment, they said, was to arrest these rebel leaders. So when John Hancock and Adams were safely salted away, a Dr. Sam Prescott suggested they head on up to Concord to warn the unsuspecting colonists who were storing arms.

Concord wasn't too far away, so the three of them – Dawes, Revere, and Prescott – set out. At about the halfway point, they were met by a British patrol. Dawes fled back toward Lexington. Revere was captured. But the real hero, Dr. Prescott, was the only one of the three who made it to Concord, and he passed the word.

A few hours later, when the troops did march into Concord, they met the first resistance of the war. And at the outskirts of Concord that same day, the famous shot, described by Emerson as being "heard round the world" rang out, and several soldiers – on both sides – fell dead at the old north bridge. Not 200 yards away, from his bedroom, William Emerson, the father of Ralph Waldo, watched the entire incident, a fact which doubtless helped to inspire the younger Emerson when he phrased those immortal words about this initial action.

Is that the way you learned it in school? Well, it wasn't the way I learned it either, but that's the way it really happened.

Someday, when I really feel brave, I'd like to tell you about my experiences in homebrewing maple syrup: what happens when you confuse the sap from a diseased elm with the good stuff from a sugar maple, and the curious effects on wallpaper when the kitchen stove is used for the boildown process. Later, though – I've taken enough chances for one issue.

A Word to Authors

A very large percentage of you readers are part-time authors. Sometimes you write articles for 73; sometimes for Ham Radio; and sometimes for CQ. Rumblings have been finding their way recently from more and more of you fellows that payment for your services is not always easy to come by. One of our top authors even offered to write an exposé for us on the pay-avoidance policies of one of the other ham journals.

Specifically, the complaint seems to be that when an author submits a manuscript to one of the journals, an acceptance or rejection is received within a reasonable period – several weeks to two months. But when the article is accepted, the authors tell us, there is an inordinately long period of waiting before the publisher makes out a check.

As a parenthetical "aside," it is perhaps time for me to interject a word or two about 73's policy with respect to manuscripts: When articles come into my office, I evaluate them as fast as I can, usually within a few days. I place the rejects in a special basket for return to the authors. The accepted articles are graded for amount of editing required, interest value of material, eye appeal of photos, etc., and a dollar value is assigned. The article is placed in a folder and given to the bookkeeper for payment. Nobody in the production department can touch that article until it has been paid for and returned to me, the editor. There is practically no way for an article to sneak into print without being paid for first. That's our system and it was established by Wayne because

of some bad experiences he had with a former employer who let a number of authors down. Wayne has religiously upheld his emphatic resolution that it won't happen at 73.

All this notwithstanding, there are increasing numbers of reports that authors are being shortchanged by some of the publications within the amateur fraternity. Perhaps some of the authors are afraid to say anything for fear of being blackballed. But it is the journals who should do the fearing – suppose all top authors blackballed one ham publication; who then would bother to read that journal?

Maybe 73 can help. You readers who are part-time authors let me know the problems you've had trying to collect money for your material after it has been published. I will compile a record of your experiences for publication in 73. If you'd rather your name not be mentioned, you can just tell us the essentials along with a request for anonymity, and we'll have the facts that, once published, will help future authors.

To be quite frank, I am not totally naive in this issue. Before I came to 73 I submitted articles to other publications from time to time. In one instance I had to wait for five months after an article was in print before I got paid for it, and even then I was only paid after writing several unfriendly letters to the publisher. I suspect that prospective authors will begin to get better treatment if the guilty publisher reads this editorial and realizes that he'll be getting some undesirable publicity.

Be fair when you write and tell us your experiences. If you've contributed articles to the other journals and have received immediate payment, we'd like to know about that, too. There's no point in printing only the bad if there's even a grain of good in there somewhere.

Magic Ears

People sometimes get curious expressions when I refer to Wayne Green as "Magic Ears." But I have good reason; old Magic Ears hears everything. His office is on the third floor, in what we laughingly (and realistically) refer to as The Garret. Now, The Garret is a long way from just about everywhere; even those CB walkie-talkies barely hack it from Wayne's office to mine. Boistrous activity can be in full blossom in The Garret while the rest of the place is as placid as a churchyard at dawn. All kinds of things happen up there; radios go in and radios come out – desks are moved hither and thither – test equipment gets stacked up one day and vanishes the next – bookshelves come and go. But there's never so much as a stir as far as the rest of the inhabitants of 73 can hear.

It seems only logical that if what happens in The Garret can't be heard downstairs, the converse must also be true. And maybe it would be true except for that special ability of old Magic Ears. Three floors down and a hundred yards away a printing press will stop running. Seconds later, there's Magic Ears, wondering what the holdup is.

Two flights down and on the other side of the mansion from The Garret, an interesting but quiet discussion will develop. At about the high point, in will walk Magic Ears, completely prepped on all facets of the discussion that have taken place before his entry.

But the most fascinating aspect of Wayne's phenomenal ability is when he's operating the station. He hears calls, locations, facts and figures, names, and other vital statistics when I would swear there's nothing but noise coming from the speaker. The last time it happened, I sat down beside him at the operating table with my ear glued to the speaker; I was convinced he was putting me on.

Right after he put out a short CQ he pressed the transmit switch and called UV3FD in Moscow, seemingly returning a call. There were several short exchanges, and each time I strained my ear at the receiver trying to hear the drummer Magic Ears was marching to. I watched him fill in his log: 0420Z, UV3FD, Al, Moscow. If I were to tell you that I was skeptical I would be grossly understating the facts.

But believe this or not – and I can still hardly believe it myself – some semblance of a signal began to work its way up through the mire there on 14.205. And suddenly, amid the din and garbage that characterizes 20 meters, there was Al. He had been asked about his occupation and was making his retreat after "an enjoyable discussion." Calling Wayne by name, he then signed off, giving both his call letters and Wayne's.

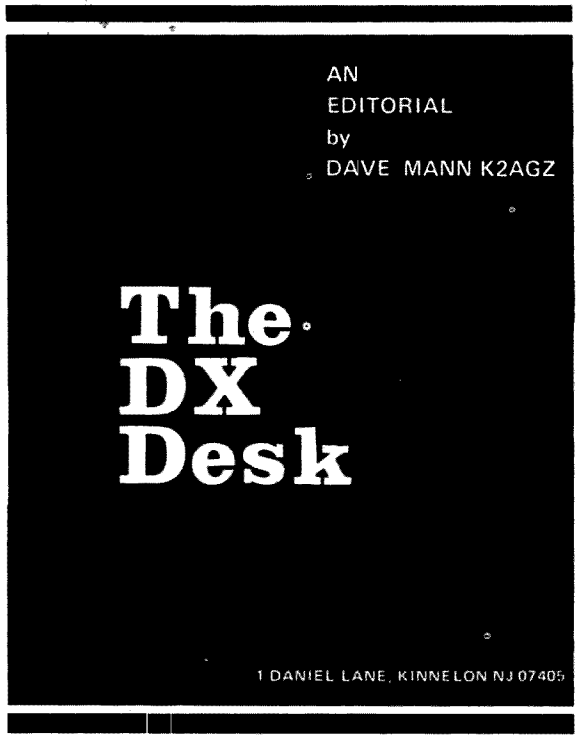
I don't know how he does it. But don't feel bad if you enter a contest and get beat out by Magic Ears. That's the breaks – some of us have it, some don't. ... K6MVH ■



"Not Yiddish, you lid! British!! Bravo, Romeo, India..."

If the attitude of some amateurs is to be credited with any validity, there would seem to be a grossly misunderstood provision of the regulations, or at least of the FCC interpretations and administration of those regulations. I refer to the rules governing third party traffic.

There are cases in which it would be normally assumed that violation notices would inevitably ensue. But there are other instances which pose some doubt. There is an area of ambiguity in the minds of many, although the rules are spelled out with clarity. I find the following passage in the ARRL License Manual, page 65 in my issue: "Amateurs may handle, in emergencies, traffic relating directly to safety of life or property."



In a recent instance during the passage of priority emergency medical traffic, some overzealous, self-appointed vigilantes were heard to make snide comments, causing unwarranted interference, and making pests of themselves. A physician-ham, WA2RAU, was attempting with difficulty to ascertain the exact particulars of a life and death case in an African locality, in order to determine the proper drug shipment to the patient's doctor. The traffic was finally passed, but it took four times as long as it would have taken if it had not been for the interference from persons who took it upon themselves to intrude. It could be that in their determination to horn in, they themselves might run afoul of a few regulations and run the risk of violation notices. And in this particular instance this would have been poetic justice, in my view.

In order to clarify this situation concerning the rules for third party emergency traffic, the FCC District of Columbia Bureau was called. A man named Mr. Sam Ferraro gave the caller permission to quote him directly. This is what Mr. Ferraro said:

> "Under any circumstances, emergency, that is, life and death traffic, is permissible by the FCC with *any country*."

He stated further that the Commission will not prosecute any ham for handling any emergency traffic with any country. In other words, not only is such traffic permissible, but the FCC policy is that it does not wish to discourage it by implying any threat of prosecution or other punishment.

Unfortunately, there are some who insist upon complicating the simplest matters. Certain net control stations, in spite of Mr. Ferraro's assurance, have stated that they would still insist upon *written permission for each such emergency*. This rigid approach, sadly, does not fit in with the nature of emergencies! While an operator is chasing around in order to satisfy these requirements, cutting all the red tape strung by these petty, picayune martinets with their own homebrew regulations, a seriously ill human being, waiting for a life-saving drug, might be expiring in his final agony!

Let's get it straight, once and for all. If there is a medical emergency, and if an amateur decides on the basis of the information that it is indeed a matter of life and death, therefore serious enough to fall within the limits of the regulations, don't let's all jump in to advise him of the third

party rules. . .he knows them as well as we do. And he is mature enough to determine for himself the consequences of his own actions, without reminders from the rest of us. All we succeed in accomplishing with our unsolicited advice is to cause confusion and interference.

If the stations require relaying, translation, or other assistance, they will request it. But there is nothing worse than the bedlam caused by a mob, all talking at once, making nuisances of themselves, when a life may be hanging in the balance.

And while on this subject, I would like to toss a few orchids to those intrepid doctors among us, who have been doing this mercy work, to the everlasting credit of ham radio. The aforementioned WA2RAU, Sam Rosen, has been involved in so many such jobs that it would be impossible to calculate the numbers of lives which have been affected. Of my own knowledge I can recall a few of these. Doc sent over $300,000 worth of drugs to a certain country. The certificate which was issued to him by this grateful nation states that the drugs were responsible for the saving of 38,000 lives. He spent 72 hours running continuously, working patches during the Alaskan earthquake a few years ago. He has pestered the large pharmaceutical houses, promoting these shipments of drugs, and arranging for the airlifts by which to transport them. The drug companies may regard him as a pest, but he always succeeds in getting them to send the drugs. And for that, he's more than willing to be called any name they can think of.

I've selected Sam at random. I can assure you that there are dozens of these dedicated men, fulfilling one of the finest functions a ham can possibly find. In my opinion, for what it's worth, I regard such drug shipments to be at least as valuable as the Peace Corps, in terms of enhancing the image of the United States of America.

* * *

DX has not provided us with too many exciting events in recent months. True, we have had a new country, Market Reef, OJØMR, a rather surprising one which came out of the blue. AC3PT was activated for a short while by Dr. Fred Lieberman, a music professor from Brown University, who was in Sikkim to tape the songs of the hill people. That station is owned and operated by the Maharaja, P.T. Namgyal. He does not get on the air very frequently, and when he does, he becomes confused by pileups, and leaves as soon as the confusion begins.

There is current activity at Qatar, with a fine operation, MP4QBK, on both phone and CW on 15 and 20, with special permission from the Sultan. ZS2MI, Marion Island, has been coming through with booming signals. And W9FIU/KS4 has been 5/9 from Serrana Bank.

There are a few items due to come up this year which will make it a memorable one for the DX fancy.

One of the most exciting was Wayne Green's operation from JY1. This was one of the most intriguing prospects in a good long time, since JY is one of the most wanted prefixes on everybody's list. The JY episode, however, is Wayne's own story, and he's included it this month under "Never Say Die."

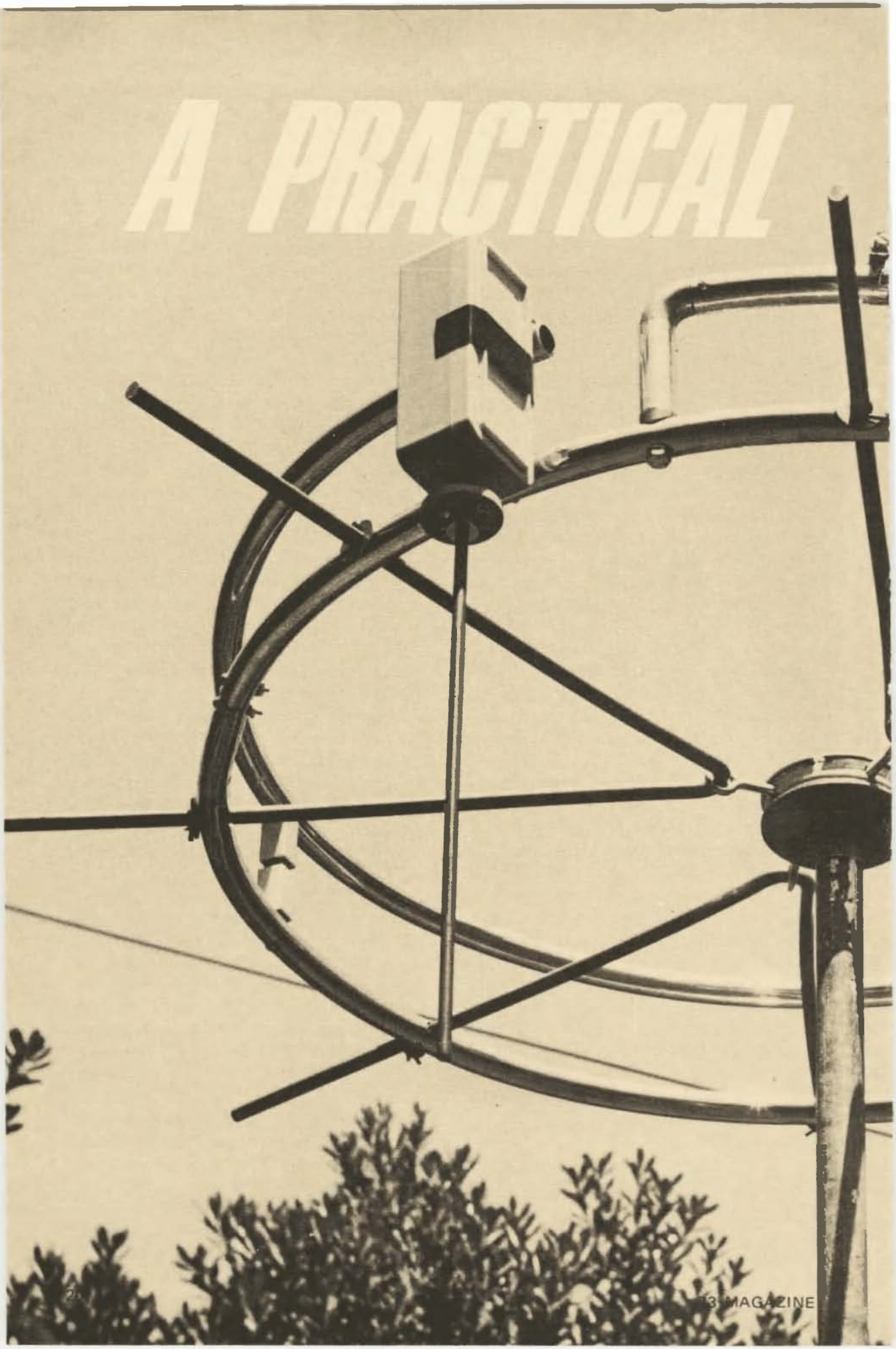
We hear all sorts of rumors concerning a French operator, testing on FO8, Clipperton Island. It is said that the chap is there on some sort of installation in connection with a satellite tracking station. It is further rumored that a regular amateur operation will be activated. This is another of the most wanted ones.

The projected Spratley expedition, which was due to begin shortly, has had to be tabled, due to a leaky schooner hull. Jens has slowly been making his way toward Hong Kong for the repairs, and then he is supposed to resume the trip. This one will take about two years, according to the best information, and should afford us a number of interesting possibilities.

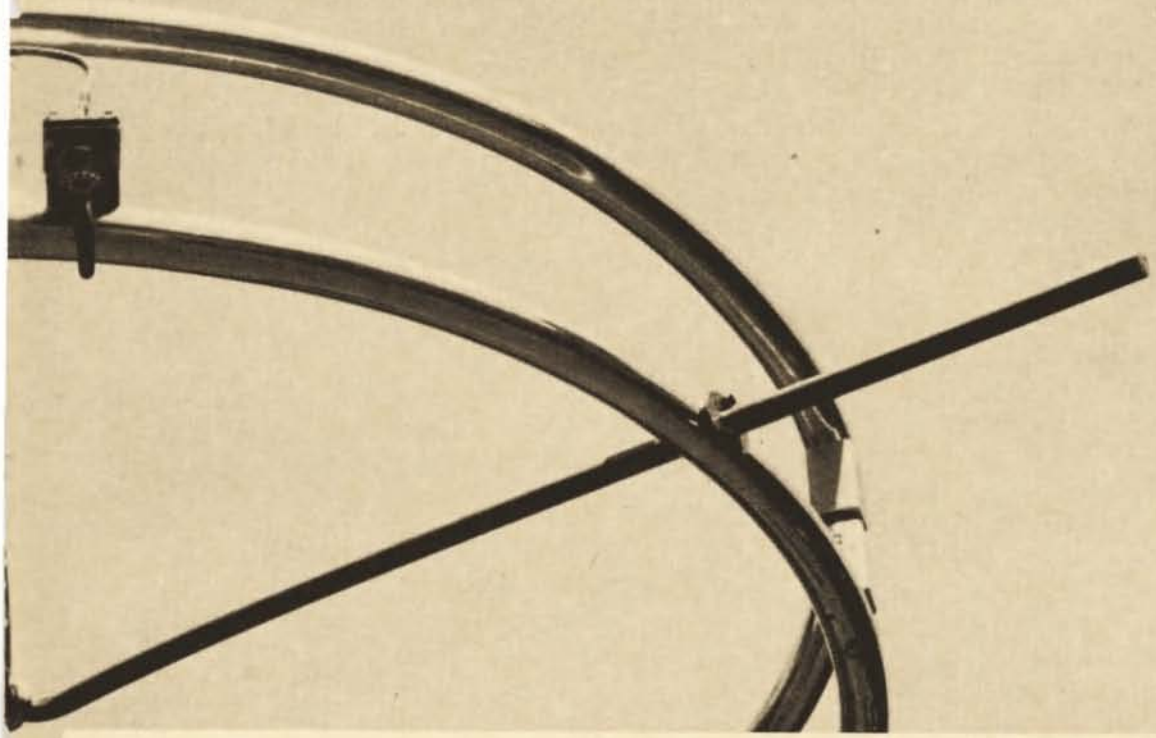
Our old pal Gus is planning another DXpedition for the Spring, also. Let's hope that all the details are ironed out on this, and that Gus will be successful with all the preparations. It's just what is needed to give DX a shot of adrenalin and put some life back into the game. We've had some

(continued on page 143)

A PRACTICAL



DDRR ANTENNA



Since the DDRR (Directional Discontinuity Ring Radiator) was first announced by its inventor, J. M. Boyer; and the article by Clifford E. Hicks appeared introducing this new antenna to the ham fraternity, very little serious work has been done in this area. Yet this lightweight, compact antenna has many features which recommend it for use by hams. I, for one, have found it a most interesting antenna to work with. In spite of its many advantages the DDRR has some drawbacks which might discourage the otherwise interested amateur.

The two major problems are: construction difficulties which stem from the unorthodox (to the average antenna builder) fabrication of the DDRR, and the extremely high voltage which develops at the termination of the fed ring. The former tends to discourage experimentation because of the difficulty of bending tubing with reasonable accuracy and in arriving at a configuration with the mechanical stability that the sensitive nature of this antenna demands. The latter challenges the average junkbox to produce a tuning capacitor which will withstand the voltage and not

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exceed the dimensions of the antenna itself. Indeed, it is difficult to locate a suitable capacitor for this service among the standard units available from the manufacturers. Another discouraging factor is the fairly large ground plane employed, which makes the antenna difficult to mount and gives it the appearance of a hovering flying saucer.

After working with antennas of this nature since 1965, I have evolved a design which overcomes, or at least minimizes, these problems. This design is such that any amateur, reasonably proficient with common hand tools, should be able to construct a DDRR antenna which will not only work well, but which is also easy to mount and easily equivalent to a quarter-wave vertical in performance.

For those who may not be familiar with this extremely interesting radiator, a brief description is in order. Essentially the DDRR consists of a quarter-wavelength element bent to form a ring, open for a small percentage of its circumference, mounted, horizontally, a few inches above a ground plane surface. The feedline is connected between one end of the circular element and the ground plane. It is usually tuned at the end farthest from the feedpoint by means of a low-capacitance variable condenser between the ring and the ground plane. (See Fig. 1.)

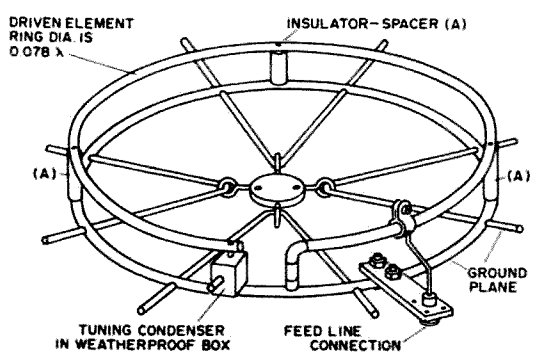


Fig. 1. Basic DDRR.

In contrast to its appearance, this antenna, like a ¼-wavelength vertical, develops a vertically polarized radiation signal. It is also interesting to note that this antenna displays exceptionally high Q and is sharp enough in tuning to be considered an additional tuned circuit in the communications loop. If the fed end of the discontinuous loop is grounded to the ground plane surface, the antenna can be shunt fed with coaxial cable (I used 50Ω RG-8/U and easily achieved an swr of 1.1:1). The physical size of the antenna is one of its most significant advantages. Since the ring is only .078 wavelength in diameter and the ground plane but 25% greater than that, with overall height for any frequency a matter of inches, it is easy to see that the DDRR is an amazingly compact antenna. The 10 meter antenna has a maximum diameter of 36 in. and an overall height of 4 in. The 2 meter version is almost pocket-size, 8 to 10 in. in diameter and 2 in. high.

The following construction details pertain to the 10 meter version of the DDRR. Tabular data in Table 1 provide dimensions

Table 1. Dimensions for antennas for other bands.

		10	15	20	40
Ground Plane Diameter	GPD	36"	50"	78"	135"
Feed Point	FP	1"	1.5"	2"	3"
Gap	G	2"	2.5"	3"	5"
Capacitor	C	15 pf	15 pf	35 pf	70 pf
Spacing	S	3"	4-3/4"	6"	12"
Tubing Diameter	TD	3/4"	3/4"	1"	1-1/4"
Radial Diameter	RD	3/8"	3/8"	3/4"	1-1/4"
Ring Radius	RR	28"	40"	54"	108"
	NR	8"	8"	12-16	12-16

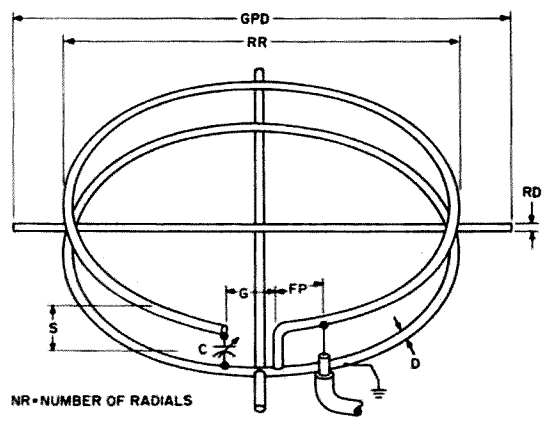


Fig. 2. Dimension key for DDRR.

for antennas for other bands. General construction details are suitable for all frequencies with sizes of assembly hardware being modified accordingly. Signifi-

cant variations, when they occur, such as with radials for low frequency units, will be described in detail.

Constructing the 10m DDRR

The solution to the construction difficulties mentioned earlier stems from use of standard hardware items commonly available in hardware stores throughout the country. If all of the recommended materials are procured before construction begins, assembling the DDRR should be little more difficult than assembling a kit antenna from the commercial supplier. (See Parts List, Table 2.)

Table II. Parts list.

Part	Source	Part No.	Quantity Required For 10	15	20	40
3/4" A1 Tubing	Reynolds	4222[4]	2	3	11	11
1" A1 Tubing	Reynolds	4242	0	0	5	0
1-1/4" A1 Tubing	Reynolds	4262	0	0	0	7
3/8"A1 Rod	Reynolds	1806	2	2	0	0
3/4" T-Butt Connector	Reynolds	7824	1	1	12	12
1" T-Butt Connector	Reynolds	7825	0	0	1	0
1-1/4" T-Butt Connector	Reynolds	7826	0	0	0	1
3/4" 90° Elbow	Reynolds	7832	1	1	0	0
1" 90° Elbow	Reynolds	7833	0	0	1	0
1-1/4" 90° Elbow	Reynolds	7834	0	0	0	1
3/4" Splicer	Reynolds	7840	1	3	0	0
1" Splicer	Reynolds	7841	0	0	4	0
1-1/4" Splicer	Reynolds	7842	0	0	0	7
1x1/4 A-1 Bar	Reynolds	1821	1	1	1	1
3/8" x 2" Eye Bolt			4	4	0	0
1/4-20 Bolt 3"	(Use 4" for 20 & 40)		1	1	1	1
3/4 x 2-1/2 Ceramic Insulator	H. H. Smith	2649[3]	3	0	0	0
1/4-20 Screws 1"			6		0	0
1/8 x 3/4 Washer 1/4" hole			6	For Insulators— See Table I		
3/4" U Bolt Turnbuckles	Inc.	T-308	1	1	0	0
Coax Receptacle SO-239	Allied	47C-0352	1	1	1	1
Variable Cap 0-15 pf	Cardwell	ET-30-AD	1	1	See Table I	
Fixture Box	Universal	56111[1]	1	1	0	0
Fixture Box Cover	Universal	54-C-1	1	1	0	0
1-3/8 x 1-7/8 x 5-1/8 (ID) Plastic Box	Loma Products	401[2]	1	1	0	0
Pipe Flange			1	1	0	0
6" Turn Buckle			0	0	12	12
1/4-20 Threaded Rod (6" Length)			0	0	12	12
1" U Bolt			0	0	1	0
1-1/4" U Bolt			0	0	0	1
Tuning Capacitor (See Text)			-	-	1	1
Insulators (See Text)			-	-	5	5
Misc. Hardware – Lockwashers, washers, cotter pins, pipe clamps, etc. (See Text)						

[1] This is an electrical light fixture box known in the trade as a "Pancake Box"—other numbers are Bowers 410, Appleton 4-CL, Raco 293.

[2] This is a Butter Dish, the Loma Classic Flair, manufactured by Loma Products, Fort Worth, Texas, available in department stores, hardware stores, etc.

[3] The larger DDRR antennas require greater spacing between elements. We found it best to make insulators for the larger units from plastic stock. The selection of these items is left to the ingenuity of the builder.

[4] Standard 1/2 inch EMT (Thin wall Conduit) can ba substituted wherever Reynolds 4222 is specified. The Reynolds fittings can be filed to adapt them to the slightly smaller inside diameter. The prototype antenna seen in many of the photographs was made with EMT. If you wish to make this substitution, you can save money, but there will be about a 30% increase in weight.

Forming the Rings

In my experience, the most difficult operation is bending the tubing to form a 28 in. diameter circle. In the pilot model the tubing was bent by hand (with a little assistance from the foot) and satisfactory results were achieved; however, a more esthetic appearance will result if a jig is used. A 26 or 27 in. bicycle wheel with the tire removed is satisfactory for this purpose. There is sufficient spring-back in the tubing to allow for the slight difference in diameter. With the wheel locked so that it will not rotate, position one end of the tubing in the groove of the rim and secure it. This can be done with a C-clamp, a vice, or simply by wrapping a few turns of wire around the rim and tubing. The free end of the tubing may be pulled around with even pressure until the complete circle is formed. If you do not achieve a perfect circle, no serious electrical problems will result; moreover, minor deviations can be corrected by tightening the radials later. The principal objective is to make two rings as close to circular and as similar as possible, with a center-to-center diameter of 28 in. When this task is completed, your DDRR is practically finished because the remaining construction is very simple.

Assembling the Ground Plane

Join the ends of one of the rings using the coupler (Reynolds 7840). Be sure to allow for "makeup" for inserting this part. To do this, the total circumference of the ring should be cut ¼ in. shorter than required.

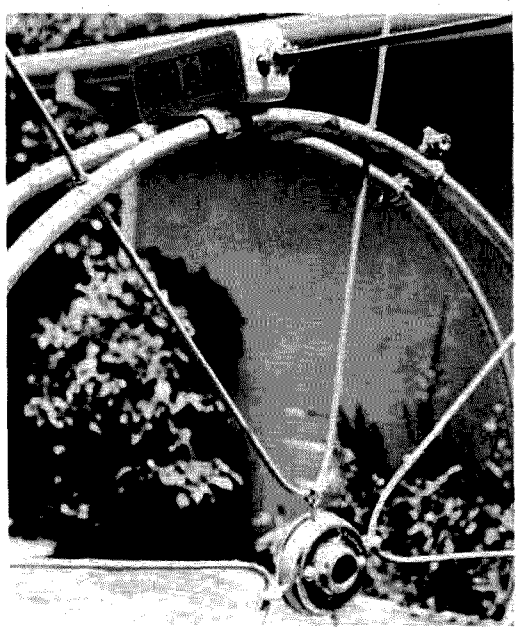
Measuring around the outermost perimeter of the assembled ring, divide the entire ring into 8 equal parts. This spacing, measured around the perimeter, is approximately 11¼ in. Mark each division on the centerline of the tubing with a center punch. Drill completely through the tubing from the center punch mark toward the center of the ring with a 7/16 in. drill. These drilled holes are for the radials.

Cut the 3/8 in. rod (Reynolds 1806), into 36 in. lengths. Bend each length of the center to an angle of 45°. Drill a 1/8 in. hole in each leg of the vee 6 in. from the ends.

Thread a 3/8 x 2 in. eyebolt onto each of the four vees and let it hang at the mid-point.

Mark the fixture box (Universal 56111) around its perimeter at the mid-point between top and bottom. Mark the 90° points around this line with a center punch and drill each point with a 5/16 in. drill. Make sure that the eyebolts remain on the inside of the assembly. Push the vees out far enough to leave about a 6 in. diameter at the center with all of the vees installed. You may find it difficult to get radials started in the holes, but they will go and fit easily when in the final position.

With the ring and radials resting on a flat surface, place the fixture box in the center. Pass the threaded end of the eyebolts through the holes drilled in the sides of the fixture box and run a nut onto each of the eyebolts until one or two threads are visible past the nuts.



The prototype DDRR, a view from the bottom showing details of the hub, mounting flange, feed connection, and tuning condenser.

Slip a washer over each rod tip and push it past the drilled hole toward the ring and install a 1/8 x 3/4 in. cotter pin in each hole. As the work progresses it may be necessary to loosen the nuts at the hub slightly in order to fit the cotter pins and washers.

Once all cotter pins and washers are installed, tighten the nuts at the hub until all radials have equal tension and the circle is not distorted. As a check, the visible portion of the threads inside the hub should be nearly equal for all four eyebolts.

If the outer dimensions are critical for your installation, measure 18 in. from the center of the hub along the radials and cut off the excess length. If outer dimensions are not critical, just make sure that all radials are of equal length. The minimum is 18 in. from center. Any greater length, within reason, will provide a slight improvement in operation.

Turn the assembly over and install the pipe flange on the bottom of the fixture box with two ¼ in. bolts and nuts. You will find that two holes in the fixture box align almost exactly with the two holes in the pipe flange when the flange is centered on the box. When these mounting bolts have been securely tightened, install the cover plate (Universal 54-C-1) on the top of the box using the two 10-32 screws which come with the box. This cover will help to keep water from collecting inside the box and thereby reduce corrosion problems. It also adds a professional finish to the job.

The ground plane for your antenna is now complete. It should be rigid enough to be supported on a pipe, threaded into the pipe flange, without sagging.

Attaching the Driven Element

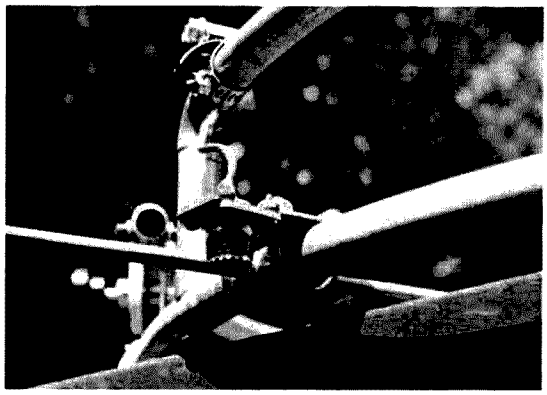
Place the second ring of ¾ in. tubing on top of the ground plane assembly and make any last-minute adjustments necessary to cause the two rings to coincide.

With a tubing cutter or a hacksaw, cut the end of the tubing so that a gap of 3-1/8 in. is left in the upper ring.

If you intend to use the base loading feed system, omit installation of the 90° elbow and its associated parts. Cut the gap in the upper ring to 6 in. and proceed with the installation of insulators. You will have to install a fourth insulator an inch or so in from the gap on the fed end of the ring.

Install the 90° elbow (Reynolds 7832) in one end of the tubing and position it so

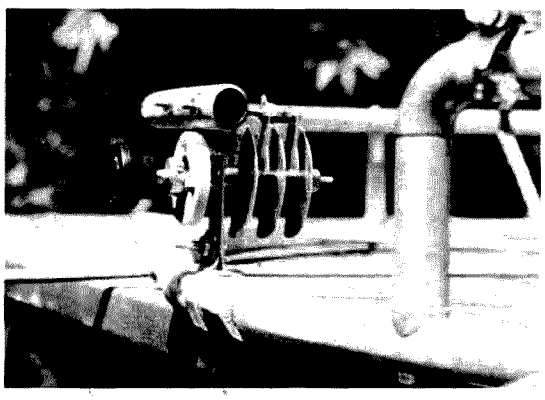
that it points downward toward the ground plane ring. The elbow comes with an expandable spring clip which is screwed onto the end of the elbow. This attaching system may be used, but it is preferable to omit it and attach the elbow to the ring by drilling a hole horizontally, through the



A view of the feedline connector attached to the prototype DDRR.

tubing and the elbow to take a 8-32 x 1 in. screw. The latter system insures a good electrical connection at this junction and is a stronger mechanical assembly, less likely to fail after the antenna is erected. This precaution was not necessary on the closed ground plane ring at the joiner, because the tension of the radials serves to hold the joint in solid contact.

Cut a 2-1/8 in. length of tubing from the scrap left over from the rings and slip it



The home-made tuning condenser mounted on the prototype DDRR.

over the remaining end of the 90° elbow. Insert the T-butt connector (Reynolds 7824) in the opening at the lower end of the short piece of tubing.

Position the upper ring over the ground plane ring so that the T-butt connector on the lower end of the elbow assembly is midway between two of the radials. Make sure that the joiner in the ground plane ring is not in a position to interfere with installation at the tuning capacitor, T-butt connector, coaxial connector bracket, or any of the insulators. (See Fig. 1.) Drill a ¼ in. hole straight down through the ground plane ring at the selected point. It is important that this hole be as close to vertical as possible. The T-butt connector may be used as a drilling guide.

Discard the bolt supplied with the T-butt connector and replace it with the 3 in. ¼-20 bolt. This bolt passes upward through the hole in the ground plane ring, through the T-butt connector and the short length of tubing, and engages the threads in the 90° elbow. Tighten this bolt just enough to take all of the slack out.

Carefully measure the distance between the centerline of the upper ring and the top of the lower ring close to the 90° elbow, to insure a 3 in. dimension. If this dimension has not been achieved, remove the short length of tubing and adjust its length accordingly. A good electrical connection at this point is crucial.

Installing the Insulators

Mark a point directly opposite the center of the gap on the upper ring and drill a ¼ in. hole directly downward for the first insulator. Measure around the circumference of the upper ring, a distance of 24 in. each side of the hole for the first insulator. At each of these two points drill a ¼ in. hole directly downward for two more insulators. Mark the corresponding points on the ground plane ring and drill each of these points with a ¼ in. drill.

Install the insulators (Smith 2649; Allied 47-C-4357), between the two rings at the drilled points. These insulators are 2½ in. in length, and a 1/16 in. washer must be installed at top and bottom of each insulator to provide the 2-5/8 in.

separation required. Fiber washers sold in plumbing supply houses are ideal here. Once again, a lockwasher under the heads of the 1 in. ¼-20 screws will serve to keep the mechanical structure solid even with vibration caused by wind.

The mechanical construction of your DDRR is now complete. The next operation is to provide for feedline connection and to install the loading condenser.

Installing the Feedline Connector

Cut a length of the 1 in. by 3/16 in. aluminum bar (Reynolds 1821) 2¾ in. long. Drill two ¼ in. holes, ½ in. and 1½ in. from one end and on the centerline. At the opposite end, drill the holes to accept the coaxial fitting (SO-239). (See Fig. 3.)

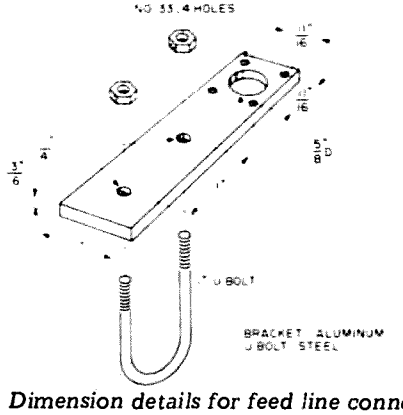


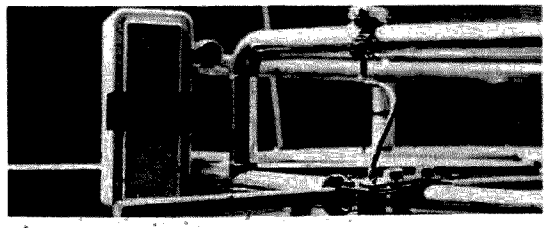
Fig. 3. Dimension details for feed line connector.

Install the coaxial fitting in the bracket and attach the bracket to the ground plane ring about 4 in. from the junction of the 90° elbow and the ground plane ring. (See photo.) The bracket should be on top of the ground plane straddling the ring and passing through the holes provided in the bracket. When the bracket has been clamped in place, any excess of the threaded ends of the U-bolt should be cut off flush with the top of the nuts. If you are planning to use the base-loading feed system, follow these same instructions, but position the bracket at about the mid-point of the 6 in. gap.

Installing the Tuning Condenser

There are a number of variables affecting condenser installation. These have been discussed in the section on condenser considerations. If you do not intend to use the recommended part, it would be advisable to review that section before proceeding. If you are planning to use the base-loading feed system, you will not need to install a tuning condenser at the top end of the ring. (See the section on alternate feed system.)

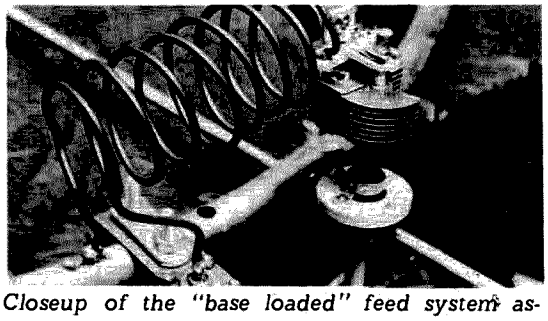
The Cardwell ET-30-AD dual-section condenser was chosen as the best component for this application, because it has the low minimum capacitance required; and, with the two sections connected in series, it withstands the high voltage encountered.



Details of the DDRR built in accordance with the instructions in the article. Note the methods of attaching the radials, the feed connections and the box containing the tuning condenser.

Since most antenna installations using the DDRR will involve manual tuning, the condenser has been oriented with the shaft extending downward. This position allows easy access for portable, mobile, or emergency installations. Horizontal positioning may be used and is advisable if motor-driven tuning is contemplated.

To mount the ET-30-AD in a vertical position with a plastic box for protection, proceed as follows:



Closeup of the "base loaded" feed system assembled on the prototype DDRR.

In one end of the box (Loma 401) drill a 7/16 in. hole on the centerline and 11/16 in. from the inside bottom. Drill four holes 5/32 in. diameter in the bottom of the box to accept the mounting screws which come with the capacitor. These holes must be symmetrical about the centerline, in pairs and on 1-1/8 in. centers. The first pair must be 13/16 in. from the end with large

holes drilled previously. The next pair must be 3-3/8 in. from the first pair and in line with them. On the centerline of one side of the box, drill two holes for 10-32 screws 1 in. from each end. In this last pair of holes, install two 10-32 x 1 in. screws with solder lugs under the head of each screw on the inside of the box. Run nuts onto these screws and tighten them securely. Install the capacitor in the box by slipping the shaft through the large hole in one end and with the mounting bars toward the bottom. Install the four capacitor mounting screws and tighten them securely. Connect a short length of wire from the solder lug under one of the 10-32 screws to the solder lug on the nearest set of stator plates. Connect the other set of stator plates to the other 10-32 screw in a similar manner. The solder lugs for the rotor, at each end of the shaft, must be cut off flush with the ceramic end plates to provide clearance for the cover.

Measure 1¼ in. in from the gap end of the driven ring, that is the end farthest from the feed point. Drill a hole horizontally and on the centerline through the tubing with a #10 drill. Directly below this hole drill a similar hole in the ground plane ring.

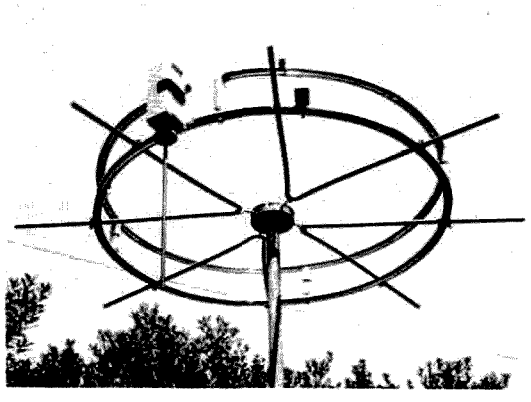
Slip the two 10-32 screws protruding from the side of the plastic box through the two holes in the rings. Be sure that the shaft is pointing down. Using lockwashers and nuts, securely fasten these two points.

Install an insulated shaft coupler on the shaft of the condenser.

There is a base attached to the cover of the plastic box which may be removed. This is the olive green portion cemented to what was originally the bottom of the box and which now serves as a cover. This unnecessary portion can be removed by carefully cutting around the edge with a knife to separate the glued area. The friction fit of the cover should be adequate to hold it in place; but for mobile service, and if the antenna is to be mounted at considerable height, it is advisable to provide some means of locking the cover securely in place. The simplest approach is to wrap the joined edge of box and cover with plastic electrician's tape, which will also provide a degree of weatherproofing.

Connect a 6 or 7 in. length of 1/8 in. flexible braided lead to the coaxial connector in the bracket. Slip the free end of the lead through a ¾ in. pipe clamp installed on the upper ring about 1 in. from the end of the elbow. Tighten the clamp only enough to provide a good sliding connection.

Your DDRR is now ready for tuning.

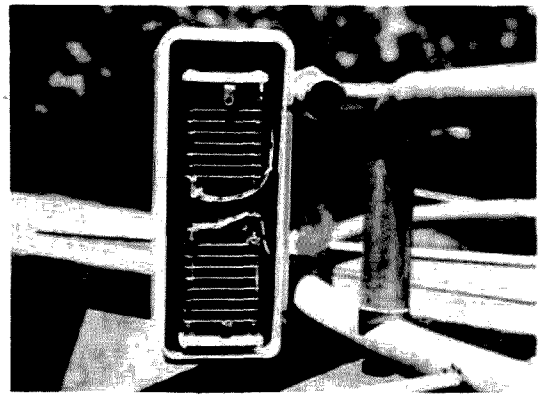


The final version of the DDRR atop the pipe mast.

Tuning The Antenna

Tuning the DDRR is a relatively simple operation, when done with an swr bridge in the line – and very nearly impossible without one. If you do not own one of these valuable devices, it would be wise to borrow, build, or buy one before attempting the tuning procedure.

With the DDRR supported at least two or three feet above the ground, connect a coaxial cable to the connector on the bracket. Install an insulated shaft on the coupler at the bottom of the tuning con-



A view of the dual section condenser installed in the "butter box" and mounted on the prototype antenna.

denser. Connect the other end of the coaxial cable through the swr bridge to a low-power rf source on the desired frequency. (I used a Globe DSB 100.) The low power is a safety precaution to hold the high voltage hazard to a minimum. With power on, *slowly* adjust the tuning capacitor for minimum indicated swr. With an insulated screwdriver or plastic rod, push the sliding connection at the feed point back and forth until the minimum swr is indicated.

There appears to be a transformer action which occurs between the different diameters of the tubing and the lead from the coaxial fitting by moving the bracket on the lower ring. You should be able to achieve a match with the bracket nearly directly under the contact point on the upper ring. Slight deviation one way or the other from this position will have no significant effect on the efficiency, so any pair of points which provide a satisfactory swr should do. Whatever the end point of the lead is, it should be direct and fairly taut so that it will not shift position later.

There will be interaction between the setting of the condenser and the position of the feed point, so it will be necessary to adjust each one alternately during the tuning procedures. Once a satisfactory swr has been achieved by adjusting the condenser and the feed point, tighten the feedline to the transmitter to be used or increase power to normal operating level and recheck the swr. If the low-power source had the same output impedance as the operating rig, no further adjustment should be necessary. If an unacceptably high swr is encountered, retune the condenser for minimum swr. You should be able to achieve an indicated swr of 1.2:1 with ease. If not, the feed tap must be reset to match the transmitter. This must be done by moving the tap slightly with transmitter power off and checking the resultant swr with power on. It is a bit tedious, but usually a satisfactory setting located in this manner will be good for any antenna location. Once the preliminary adjustments have been made, you should be able to vary the transmitter frequency over a range of ±250 kHz and maintain an swr below 2:1 without resetting the capacitor. By resetting the capacitor, you should be able to maintain an swr close to 1:1 over the entire band.

Erecting the Antenna

The 10m or 15m DDRR antenna constructed as described can be mounted atop a pipe threaded into the pipe flange bolted to the fixture box used as a hub. A length of pipe may be used as a mast or clamped to any existing tower or pole. After the antenna has been raised to the desired height, it will be necessary to readjust the capacitor setting to center the minimum swr on the desired frequency. Once this has been done, the condenser shaft should be locked in place to avoid undesirable movement from vibration. After all adjustments have been made and all mechanical connections secured, it is a good idea to give the entire assembly a protective coating of acrylic to reduce corrosion.

When choosing the permanent location for your DDRR, consider the following factors: Extreme height does not appear to be a significant consideration with this antenna. As with other antennas, it should be located clear of metal objects which might alter its characteristics. Sometimes height is the best way to accomplish this. As height increases so, necessarily, does the length of the coaxial cable. As the length of coaxial cable is increased, the capacitor setting needs to be adjusted to compensate. Therefore the final adjustment of the tuning condenser must be made with the antenna at, or near, the final operating position. This is fairly easy if the antenna is to be relatively close to the ground as in portable or mobile installations. It may become more difficult if the antenna is to be mounted atop a high tower or pole. In this latter case, if it is impossible to do the final tuning in place, one approach is to tune the antenna at the highest possible height and with the full length of feedline connected. If this is done at least one half-wavelength above the ground, satisfactory final tuning adjustment should result.

An Alternate Method of Feeding the DDRR

If the conventional tuning method proves to be too troublesome, or if you

wish to avoid the high-voltage problem, an alternate method of feed is possible.

If we consider the ring radiator as a quarter-wave vertical which is resonant just above the desired frequency, we can feed it as though it were a short vertical whip. In this case base loading lends itself to the mechanical configuration. (See Fig. 4.)

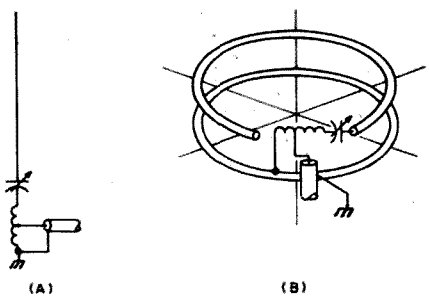


Fig. 4. Comparison between base loaded whip antenna (A) and "base loaded" DDRR (B).

Technical considerations concerning feeding quarter-wave vertical antennas in the manner described can be found in the ARRL handbook in the antenna section. The application of this method of feed to the DDRR is consistent with the electrical principles contained in the reference.

Some modification of mechanical construction is required to incorporate this method of feed for the DDRR antenna described herein. Essentially this amounts to omitting the 90° elbow and its associated hardware and replacing that part of the structure with tuned circuit elements. Mounting of these components must provide for sufficient mechanical strength and also yield the electrical characteristics necessary for proper operation.

The method devised and tested in experiments of W6WYQ is as follows:

Drill a hole horizontally through the upper ring 3/8 in. in from the end. Bolt the rear foot of a 100 pF capacitor (Johnson, Type R, 149-5), with an 8-32 screw through this hole. The capacitor shaft should point downward. Wind a coil of 1/8 in. copper tubing; 7¾ turns, 1-5/16 in. inside diameter, evenly spaced over the 4 in. length. Leave sufficient length at one end of the coil to provide a 1½ in. upright support. Solder a lug to the end of this length and bend it at right angles, in line with the axis of the coil.

Drill a hole downward through the lower ring at a point 2 in. into the gap space measured from the upper end of the fed ring. Bolt the upright support of the coil to the lower ring with an 8-32 screw through this hole. The other end of the coil should terminate at a point very close to the stator connection of the capacitor. A good solder connection should be made between these two points. Attach a length of 1/8 in. copper tubing, or similar size wire, from the coaxial connector to a point ½ to ¾ turns in from the grounded end of the coil. Some experimentation will be necessary to find the exact point for your setup. I matched a 52Ω feedline to this antenna 5/8 turn in on the coil. When mechanical mounting is complete, the gap end of the coil should be bent to re-establish the 2 in. gap prescribed for the 10m DDRR. I found that I could tune the entire 10m band with less than half of the 100 pF capacitor. The standard Type R, with .024 air gap easily handled all that the Galaxy had to offer. If you run higher power, you might need wider spacing. The Type R is available with: .036, .050, .071, and .095 in. air gap. If you must go to wider spacing to handle your power, space might be saved by going to a 50 pF maximum capacitance. Whatever capacitor is used, it should be protected with a weatherproof cover. Since minimum capacitance is not a limiting factor with this type of feed, a minibox should do nicely for the purpose.

Tuning the Base-Loaded DDRR

Tuning procedures are the same as for the shunt-fed system except that the lead from the coaxial connector is moved along the coil until a minimum swr is obtained. We found this point to be 5/8 turn from the bottom end of the coil for RG-8/U.

The advantages of this method of feed are: A narrow spaced capacitor is quite adequate, extremely high voltages are not encountered in the tuning circuit, the system is not highly sensitive to stray capacitance, and the problems of minimum capacitance associated with the shunt-fed system do not apply.

Theoretically, this method of feed should be less efficient than the shunt-fed method. This may be true for the long haul, poor conditions, DX work; however, no significant difference could be detected between the two antennas under normal operating conditions.

Expanding Band Coverage

One of the advantages of the DDRR is its high-Q characteristics, which greatly reduce noise and help to minimize interference. Unfortunately, these characteristics limit the band coverage of a fixed-tuned DDRR. This shortcoming can be circumvented by providing some means of remotely adjusting the capacitor. This consideration applies to both the shunt-fed and base-loaded feed systems. If the antenna is to be mounted close to the operating position an extension shaft is all that is required. In some installations, chain drives, pulley and cord, or other mechanical linkage can be applied. By far the most satisfactory arrangement is a low-speed reversible motor geared to the capacitor's shaft. There are numerous reversible motors available on the surplus market which would be suitable for this purpose. Since no specific unit is identifiable, no detailed installation instructions are included here. However, certain general precautions must be observed when installing any motor. To begin with, if the motor is to be installed close to the capacitor, which is the most logical location for it, the motor windings are in a strong rf field. To minimize the effects of this environment, the motor should be mounted directly to the ground plane ring and bypass condensers installed on the leads to the motor as close as possible to the grounded case. Leads to the capacitors should be as short as possible. The power lead for the motor should come away from the antenna as nearly as possible to a right angle with the ground plane for a distance of one-half wavelength. A well grounded shielded cable would be an advantage, but is by no means mandatory. There is no requirement to incorporate a selsyn indicator in the system as the minimum swr indication is all that is required.

Capacitor Considerations

It is anticipated that many who read this article will wish to make modifications to the design to incorporate their own ideas or introduce improvements. Some will also wish to press into service some of the junkbox components they have on hand but which do not conform to the specifications in this article. Most aspects of the mechanical construction allow for fairly wide deviation; however, there are some restrictions on the type of capacitor which is suitable for the DDRR which limit the selection severely. I discovered these by the age-old method of trial and error, with the latter leading all the way. To save the adventuresome experimenter from frustration, these considerations are included here. Most of the limitations mentioned pertain to antennas for 20 MHz and above. The lower frequency antennas require more capacitance for tuning and a little stray capacity has less effect on the overall circuit. The high voltage problem, however, seems to be more aggravated on the lower frequencies.

In my experiments I first used a single-bearing capacitor similar to the E. F. Johnson Type M with .017 in. spacing. While the capacitor was completely satisfactory in terms of minimum capacitance, it arced at rf power levels above about 300W. I tried substituting a glass-insulated piston trimmer with about 1/32 in. glass walls, which arced at 400W. Next, I went to a wide-spaced unit (Bud 1543), with a .175 in. spacing. This capacitor withstood the voltage easily, but even in the fully open position, the antenna system would not resonate above 26 MHz. (It was at 29 MHz with the other components installed.) The cause of this was determined to be the high minimum capacitance caused by the large metal end bearing plates which were a little over 2 in. apart and with an area of about 4 sq in. I had on hand a Cardwell NG-35-DS which was of similar construction to the Bud unit but with end plates spaced 4 in. apart. This, too, proved to have too much capacitance, even at the minimum setting. I then found that the Cardwell ET-30-AD, specified here for the 10m unit, was entirely

satisfactory. This condenser has ceramic end plates and the minimum capacitance is well within bounds. Plate-to-plate spacing is 1/16 in. and connecting the two sections in parallel gives an effective plate spacing at 1/8 in., which is adequate for the 500W maximum power used. Wider spacing might be necessary if higher power is applied. Although the ET-30-AD was satisfactory in electrical operation, it is a little long for the installation. I hoped to find a capacitor which would fit between the two rings. Finding no suitable unit listed in the manufacturer's catalog, I manufactured one. The plates were removed from a National capacitor of similar construction to the Bud and Cardwell units which were rejected. The National capacitor was tried and rejected also, but the stator and rotor plates were mounted on shafts with a bolt and spacer arrangement which made it ideal as a source of parts. With the parts from this capacitor, a capacitor was assembled directly onto the antenna. The stator plates were bolted to the driven ring and the rotor mounted to a bearing attached to the ground plane ring by a bracket. The plates, two stators, and three rotors were spaced to about ¼ in. This arrangement seems to be the most satisfactory all around, since it not only withstands the voltage, but also fits within the limited space. This method has not been prescribed in this article because of the additional mechanical construction involved and because of the difficulties in providing a weatherproof housing for it. It is described here because it may well be that those running full legal power may have to resort to this approach in order to make the antenna work at those power levels. Of course it is not necessary to dismantle an old capacitor for parts. Suitable plates may be cut from stock. Those I used had an area of about 2 sq in.

If you have an old disc-type neutralizing capacitor (Millen 15011) this can be made to work. It is particularly well suited to fixed-tuned applications but can be used as a variable with proper linkage.

If you are only interested in fixed-tuned systems, by far the easiest solution to the capacitor problem is to install a length of coaxial cable between the two rings with the shield connected to the ground plane and the center conductor to the driven element. I found that 2-5/8 in. of RG-8/U tuned the 10m antenna to 29 MHz.

DDRR Antennas For Other Frequencies

Details for construction of the 10m DDRR described herein are suitable for frequencies down to 21 MHz. Above 30 MHz, sheet metal or screen ground plane surfaces are more easily fabricated. Smaller tubing sizes recommend copper, and soldering techniques replace pipe clamps and U-bolts. Those who wish to use this antenna on 6 or 2m would do well to review the article by G. W. Horn I1MK, in the September 1967 issue of CQ.

The general construction details described above for the 10m DDRR are applicable to lower frequency units, but below 21 MHz. The method of making and attaching the radials requires some modification. The V-shaped radials of ¼ or 3/8 inch aluminum rod do not provide adequate mechanical strength, and there is some doubt as to their electrical efficiency when used in conjunction with the larger size tubing. Moreover, a larger number of radials should be used to improve both electrical efficiency and mechanical strength. Obviously the small utility box used as a hub would not be adequate on these large antennas.

We tried several methods of making radials for the 20m antenna and finally adopted the following system as most suitable. (See Fig. 5.)

The hub on this larger antenna is a disc of aluminum ¼ in. thick and 12 in.

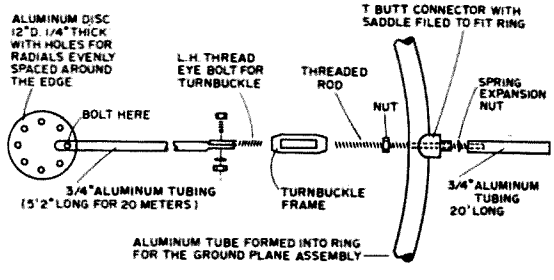


Fig. 5. Assembly technique for DDRR ground plane radials for 20 and 40 meter antennas.

diameter. The radials are ¾ in. aluminum tubing. The inner portion of each radial is 5 ft 2 in. long. A 1¼ in. section on each end of these radials is flattened and a ½ in. hole drilled through the flat part one inch from the ends. Radials are bolted to the edge of the aluminum disc, at about 3 in. intervals. The left-hand-thread end of a 6 in. turnbuckle is bolted to the opposite end of each radial; 20 in. lengths of ¾ in. tubing are mounted around the outer perimeter of the ring. These stubs are attached using T-butt connectors with the bolt replaced with a length of ¼-20 threaded rod with a nut run on it to cinch it up against the ring. The right-hand-thread-end of the turnbuckle is run onto the rod; then, by turning the turnbuckle, tension can be applied to each rod in turn. The whole assembly presents a neat appearance and is quite strong enough for pole mounting, although we added 3 legs from the midpoint of 3 radials down to the mast to provide more stability.

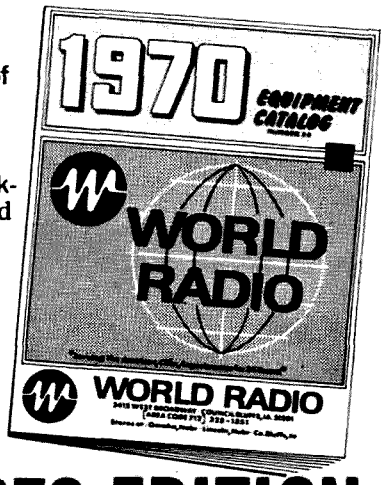
Performance

The 10m DDRR as described in this article has been in use at W6WYQ for about 4 months. On-the-air checks show its performance to be equal to that of a standard isotropic radiator mounted on the roof. The DDRR has been handicapped by being located variously: on a box in the middle of the garage, in the rafters of the garage, on the roof, on top of the car, and even resting on the ground. In spite of this, solid contacts have been made with W1s, W4s, VE7s, and many stations in between. The DDRR doesn't compete with the multielement beams, but it seems to be right in there with the verticals. It has shown itself to be superior to the multiband trap-type verticals. Most of the best contacts have been made with stations using verticals or quads, which is, no doubt, the vertical polarization of the DDRR antenna being demonstrated. The sharp tuning characteristic markedly reduces QRM and noise, and that aspect has been quite enjoyable.

The 20m DDRR is presently undergoing evaluation at another station. Initial tests indicate that its performance is very similar to that of the 10m version. . . . W6WYQ ■

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VFO CIRCUIT

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If you want a stable, simple vfo for 80 and 40 with full bandspread on both bands and possible 20 meter usage with bandspread on about 2/3 of the dial, read on. This is basically the rig from *GE Ham Tips* of March-April 1959 without the complicated inductance and capacitance switching which is used there to get full bandspread on all bands.

This unit starts at 160 then doubles in the plate circuit to come out on 80. Switch S1 (Fig. 1) cuts out C2a and inserts C3 in order to give full bandspread when doubling in your transmitter to 40. Depending on the slug-tuned form you used and the BC capacitor, you may have to juggle the turns of L1 and possibly C1 to get full 1.75-2.0 coverage, and C3 may be somewhat different

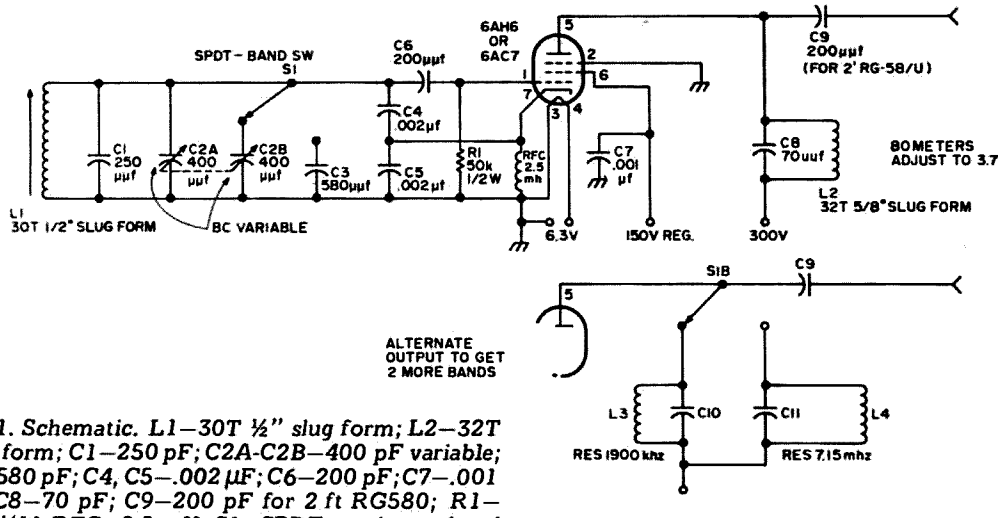
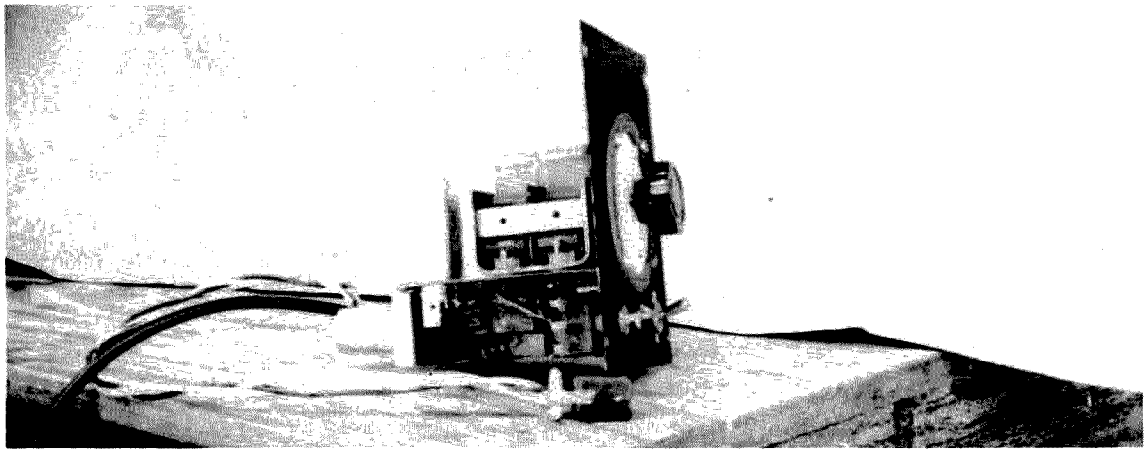


Fig. 1. Schematic. L1—30T ½" slug form; L2—32T 5/8" form; C1—250 pF; C2A-C2B—400 pF variable; C3—580 pF; C4, C5—.002 μF; C6—200 pF; C7—.001 μF; C8—70 pF; C9—200 pF for 2 ft RG580; R1—50K ½W; RFC—2.5 mH; S1—SPDT toggle sw—band sw.



As this view of the unit with its cover removed shows, the vfo can be attractively packaged within a very small volume. Power is furnished to the unit from the transmitter. If no "external power" connector is provided on the transmitter chassis, it can normally be installed with little effort.

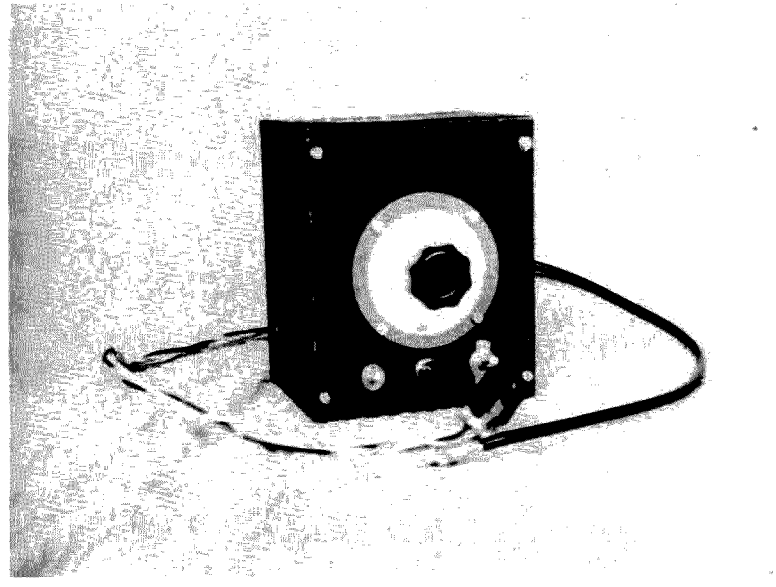
from mine in order to get full bandspread on 40.

The fixed condensers I used were ordinary micas from the junkbox. Probably as a consequence, the vfo takes about 15 or 20 minutes to settle down where it will stay zero beat with a BC221. I know that I should spend a couple of bucks for zero or negative-temperature-coefficient ceramics so that it will not drift more than a hertz or two from a cold start, but my old much-chopped-up National 100X takes that long or longer to settle down, so what good is it to have a vfo that stabilizes faster? Obviously though, the better the fixed condensers you use, the better the stability.

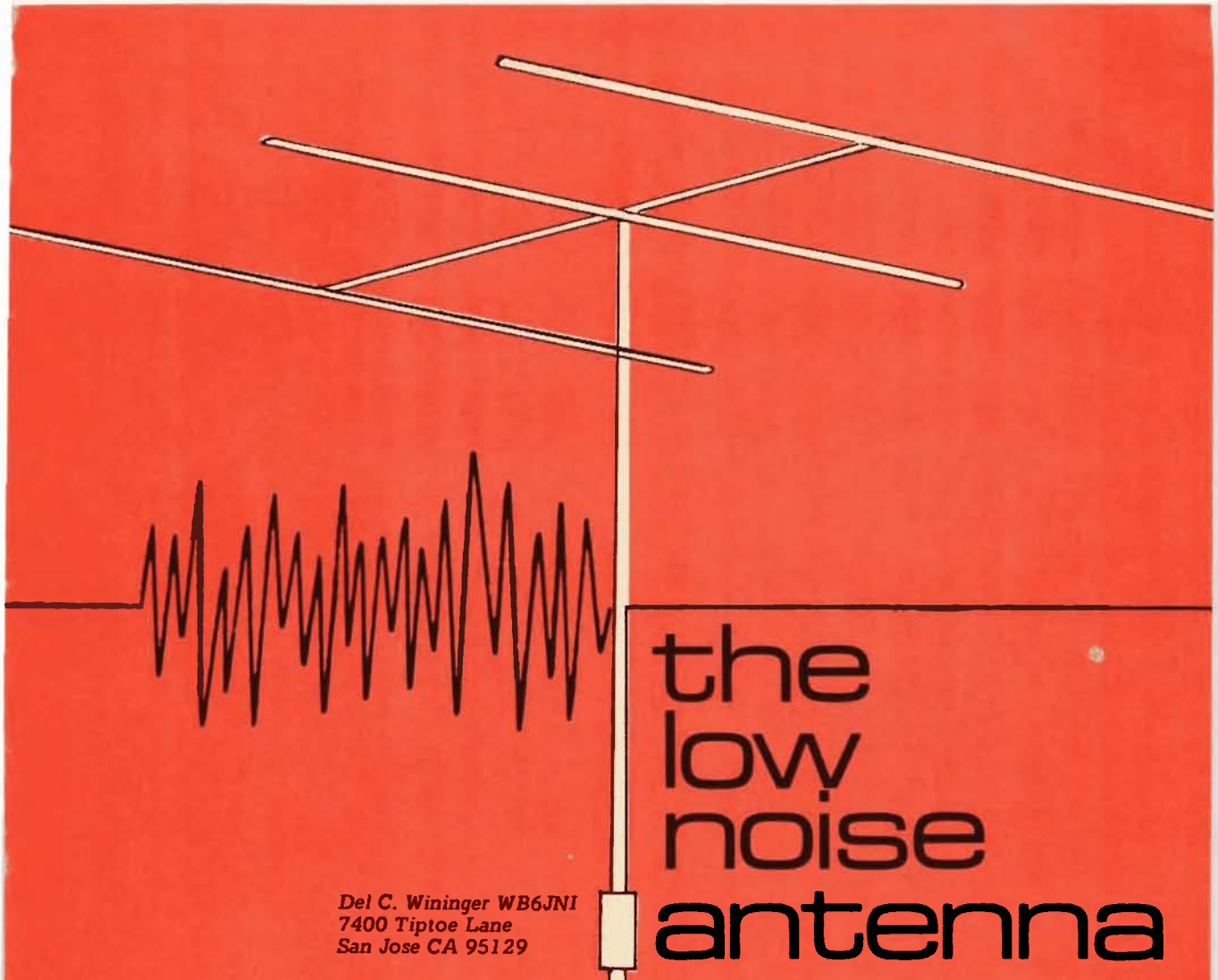
This is my first vfo project and if the same is true for you, take heed! *Don't* put a pilot lamp right under the confounded main tuning capacitor! It sure makes a nice looking, symmetrical front panel, but does it ever play hob with drift! Also, keep all tube heat away from L1. I put the tube on the back, outside the case.

One further suggestion you may want to try: Make S1 a DPDT unit and follow the suggested alternate output circuit. Make L3-C10 tune 160 meters and L4-C11 tune 40. This will give a 160 meter output in addition to the former 80 and 40, and better 20 meter usage than is the case with the simpler circuit (since you will be only doubling to get to 20 instead of quadrupling).

. . . KØHVK ■



What's wrong with this picture? The pilot lamp has been installed immediately below the tuning capacitor. The glowing lamp looks great when the vfo is in use, but the heat of the lamp does interesting things to the frequency of operation.



the low noise antenna

Del C. Wininger WB6JNI
7400 Tiptoe Lane
San Jose CA 95129

The hypothesis of antenna reciprocity—that is, a good transmitting antenna is a good receiving antenna — is only conditionally true. A tuned antenna will give you a signal that is twice as loud as an untuned antenna, but it may have four times the noise. The controlling factor in the noise transfer is the impedance match. For efficient transmission of power, the reflected antenna impedance must match the transmitter output impedance. But, "...the best receiving noise figure is usually obtained with some degree of mismatch between the receiver and the antenna." The quote is from S.N. Van Voorhis, MIT Radiation Series Volume 23.

I found this out experimentally while looking for a better signal. I have two antennas, a 13 ft vertical for the receiver, and a balun-fed three-band inverted vee for the transmitter. The transmitting antenna is trimmed to an swr of 1.5:1 in the middle of the CW section of each band and pushes 40W very nicely.

Bearing in mind the adage that says you can't work 'em if you can't hear 'em, I put the transmitting antenna on the receiver. Although the signal was twice as loud, the noise was almost impossible to work through—I heard it, but I didn't believe it! Then I did a little research.

The signal-to-noise figure is dependent upon a poor match for the noise and a better match for the signal. This can be obtained at the expense of signal gain, but most receivers have plenty of gain to spare.

There are a large number of variables in any working system and one cannot say that any specific fix will lower your signal-to-noise ratio; but at least now you know that it is possible to improve the situation by experimenting. Just remember that the loudest signal will not necessarily be the most readable. ...WB6JNI ■

John J. Schultz W2EEY, 1829 Cornelia St., Brooklyn NY 11227

REMOTE SWR INDICATOR

Conventionally placed swr meters often do not indicate the true swr at the transmission line/antenna junction. Remote location of the reflected power sensing portion of an swr unit is the key to true swr value indication.

Rather than using a combined swr indicator and sensing unit in the transmission line by the transmitter, there is a great advantage to placing the swr *sensing* unit at the junction of the transmission line and the antenna. For one thing, the true swr would then be shown on an *indicator* placed by the transmitter rather than an swr reading which depends upon transmission line attenuation characteristics. Also, one would have a means of checking the condition of the transmission line continuously, all the way to the antenna termination.

The constructional problems in placing the sensing portion of an swr unit at the far end of the transmission line have prevented most amateurs from building a remote-type swr meter. A separate enclosure must be used for the sensing unit which adds additional weight at the antenna. Generally, this would be no problem with a beam antenna where the boom can be used to support the necessary enclosure. However, such an enclosure could cause quite a droop in the center of a thin wire antenna. Another problem is transferring the output from the sensing unit to the indicator unit at the transmitter, unless a separate wire pair is used for this purpose.

Most of these problems have been overcome in the simple experimental swr unit described in this article. The unit described was constructed for use in a 300-ohm twinlead transmission line, but the techniques used are applicable to other impedance transmission line systems. Some minor problems that are noted later arose because of the particular antenna system in which the unit was tried, but the basic validity of the construction and circuitry used was established.

Basic Units

Figure 1 shows the arrangement of the swr sensing and indicator units in the transmission line. The sensing unit is a

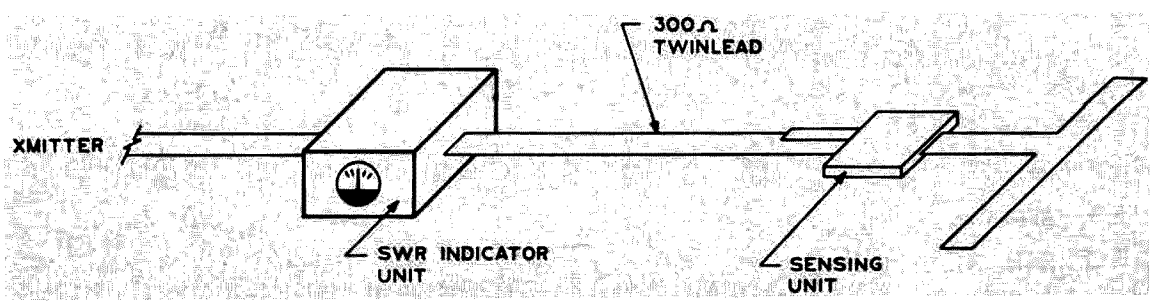


Fig. 1. Basic setup of components used in the remote swr monitoring unit.

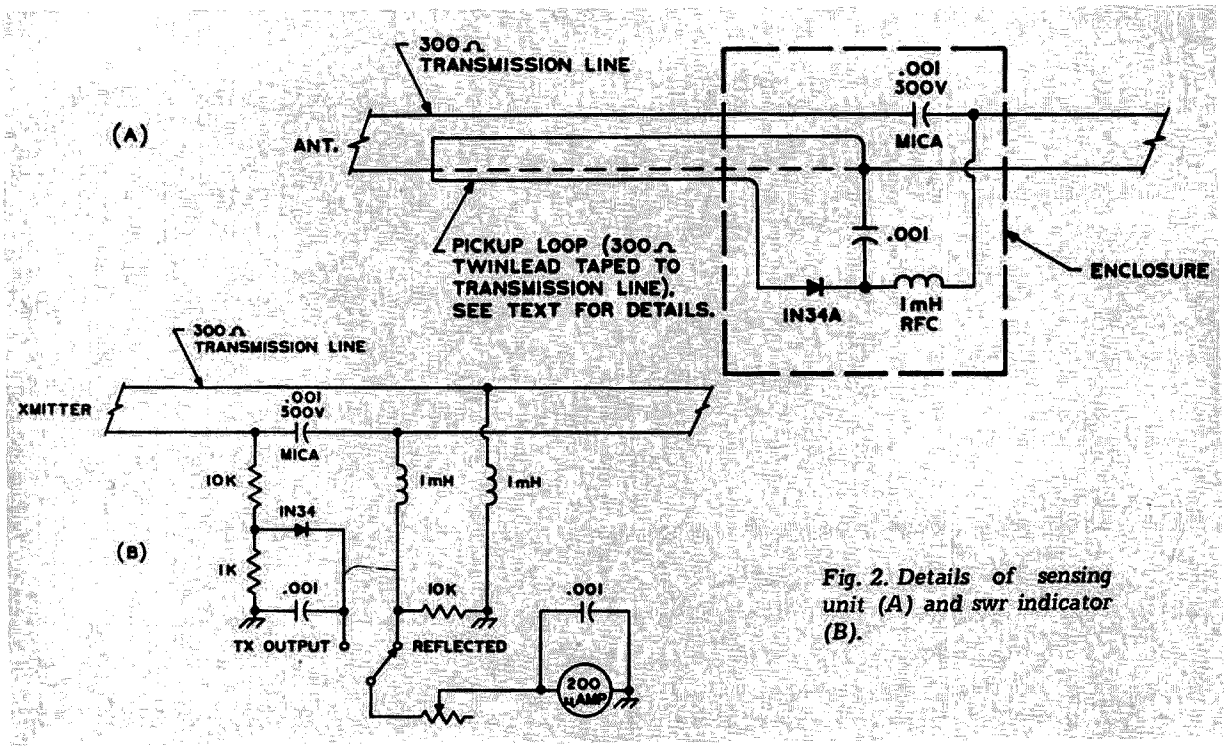


Fig. 2. Details of sensing unit (A) and swr indicator (B).

modified form of the old twin-lamp swr indicator for twinlead transmission line but arranged to only respond to reflected power pickup. The indicator unit functions as a combination rf voltmeter to indicate the relative power output of the transmitter and as an indicating dc voltmeter for the reading of a dc voltage generated by the sensing unit which is proportional to the swr. The connection between the two units is via the same transmission line between the transmitter and antenna. The same line can be used simultaneously for both purposes since the rf power flow and the dc voltage generated by the sensing unit can flow on the same line but then be separated by appropriate capacitor and rf choke combinations. This feature is indicated more clearly in Fig.2(A) and 2(B) which show the details of the sensing and indicator units.

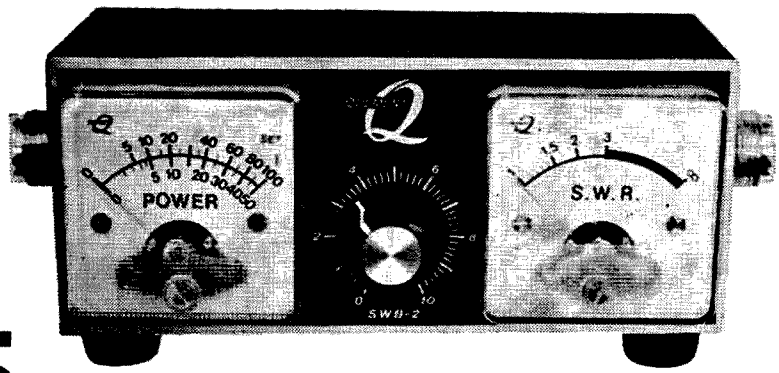
The sensing unit consists of a length of 300-ohm twinlead identical to that used for the transmission line. The assembly is taped onto the transmission line. One end is terminated in a short. A small rectifier/capacitor unit is placed at the other end where a pilot lamp would normally have been placed in the old "twin-lamp" swr indicator. The dc voltage generated is placed on one side of the transmission line via the rf choke. The dc blocking capacitor prevents a dc short circuit path from existing via the antenna (a folded dipole, for instance). The dc voltage, then, which is proportional to the reflected power level at the transmission line/antenna junction is transferred along the transmission line to the transmitter as a dc voltage difference between the two transmission line conductors.

At the indicator unit, a dc ground reference is established via an rf choke to ground for the side of the transmission line directly connected to the sensing unit pickup loop. The rf choke and blocking capacitor in the other side of the transmission line perform the same general function as in the sensing unit, only this time the capacitor is used to prevent a dc short between the transmission line conductor via the transmitter output circuit. A resistor voltage divider network and rectifier circuit on the transmitter side of the blocking capacitor provide a dc voltage proportional to the transmitter output level. The meter is switched between reading this voltage and that transferred along the transmission line from the sensing unit. The variable resistor in series with the meter allows the meter to be adjusted to a "set" value before being switched to read swr. However, the operation and meaning of the "set" reading is

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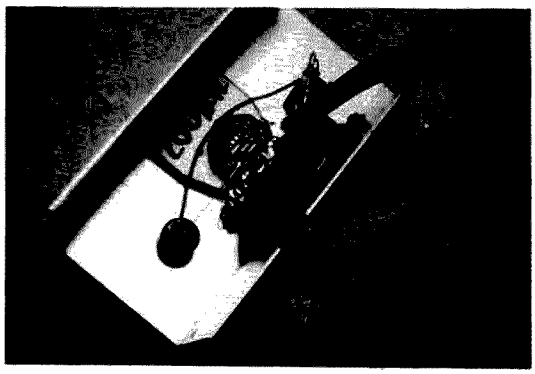
quite different from that of the usual swr meter. The differences, which are explained later, should be well appreciated.

Construction and Adjustment

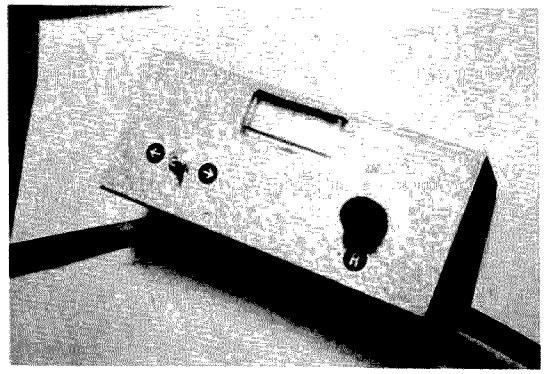
The use of the swr indicator was mainly checked on 40 and 20 meters. The length of twinlead used as the pickup loop was taped to the transmission line. The components shown in Fig.2(A) were compactly assembled in a plastic snap-open box measuring about 2 x 1 x 1 in., which was acquired as the result of some now unknown purchase. However, almost any similar lightweight enclosure would suffice. Particularly when dealing with coaxial transmission lines, it would be advisable to also use a shielded enclosure instead of a plastic unit in order to preserve the continuity of the outer shield. With some care in construction, it would seem to be perfectly feasible to use the smallest minibox available for this purpose (Bud CU3000A).

The indicator unit, as shown in the photograph, was assembled in a Bud CU-2103A enclosure. Most of the components were mounted on a 6-lug terminal strip to which sections of twinlead going to the transmitter and antenna were also connected. Before soldering to the terminal strip, the twinlead sections were passed through access holes drilled in the mating part of the minibox enclosure. The toggle switch and potentiometer used were special miniature types and, therefore, appear quite small in relation to the other components. Regular size components can, of course, be used and there is more than ample space for them in the enclosure specified.

After connection of the sensing and indicator units in a 50 ft transmission line, the far end of the line was terminated in a 300-ohm dummy load and the line swr checked using a conventional swr meter. This was done to verify that the rf chokes used in the sensing and indicator units did not upset the line conditions. Although the chokes should present a reactance of some 40 kΩ on 40 meters, it is possible that some odd resonant condition might affect their performance on a specific band. The swr was found to be essentially 1:1. Next,



All components are assembled on a terminal strip or wired between it and the panel components in the swr indicator unit. IN34 diode is shown connected between terminal strip and switch on right side. Panel unit on left is miniature potentiometer.



Front view shows simple controls arrangement. Meter scale must be calibrated for various swr readings as described in text.

while using a transmitter with about 50 watts output, the "set" potentiometer in the indicator unit was used to obtain a full-scale meter reading with the switch set to measure the relative transmitter output. A deliberate swr of 2:1 was then introduced by substituting a 150-ohm resistor for the 300-ohm dummy load. The switch in the indicator unit was set to measure the reflected power and the pickup piece of twinlead connected to the sensing unit – extended as necessary to produce about a .2 reading on the meter's 0–10 relative scale. About 2½ ft of twinlead was required. The same procedure was followed using other resistors, as available, to simulate different swr indications. Of course, the length of the twinlead pickup piece cannot be changed once established. One has to accept the relative reading that results on the meter scale for various swr measurements (or make a new meter scale). Also, during the calibration of the scale for swr, the potentiometer setting should never be changed.

The above procedure calibrates the indicator unit for a particular set of conditions – transmitter output, frequency, and transmission line length. Once calibrated, the swr unit can only be used under different conditions with some reservations. The calibration will remain correct for a range of transmitter powers, the same as a conventional swr meter. The potentiometer in the indicator unit is used in the same manner to "set" the meter while reading the relative transmitter output. The calibration will not remain correct over a very wide frequency range since the pickup proportional to reflected power will not vary in the same manner as that used to measure the relative transmitter output – unlike the action in a conventional swr meter. The calibration will generally remain correct over two bands and the scale can, of course, be specifically calibrated on any band. The calibration will also be affected by any major change in the transmission line length due simply to change in ohmic resistance affecting the transfer dc flow from the sensing unit.

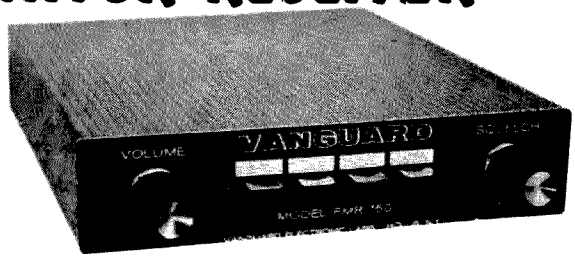
Practical Results

The swr unit described in this article was developed as an experimental idea and it was not expected that it would work in practice the first time without some flaws. Actually, the test results with an antenna were surprisingly good. Used with an antenna that had previously exhibited essentially a 1:1 swr with a 50 ft twinlead transmission line, the indicated swr using the remote swr system was about 1.5:1. This difference in swr reading probably was due to "antenna current," since the transmission line could not be run away exactly at right angles from the center of the antenna. Also, using a shielded enclosure for the sensing unit might have helped. As best as it could be done, various discontinuities resembling transmission line faults

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were created. The faults were reflected in the readings observed on the indicator unit – a situation which would not occur with a fairly long transmission line. Some of the faults created were observed on the indicator unit as even a slight improvement in swr – as when metal foil was wrapped around portions of the transmission line or antenna to simulate dielectric condition change. But, the foil probably acted in some manner to improve matching conditions, such as a stub would. The important thing is that changes in the transmission line or antenna condition were indicated. Drastic faults such as an open conductor were clearly indicated by a high rise in the swr on the indicator unit.

Summary

There are many refinements that could be incorporated into the swr unit as described. Nonetheless, the type of swr monitoring scheme demonstrated is a definite advance over conventional ones.

Ideally, it should be possible to place a sensing unit at the far end of the transmission line which would transfer back near the sensing unit and antenna faults *over the transmission line* voltages proportional *both* to the forward and reflected powers at the sensing unit. Then, one should be able to monitor independently the transmission line condition and the swr existing at the very termination of the transmission line. One could build a suitable sensing unit if two independent dc paths from the sensing to the indicating units were available. The only simple solution to this problem would seem to be the use of a shielded balanced transmission line, either 70 or 300 ohms impedance. More sophisticated, time-sharing current flow schemes over a two-conductor transmission line are certainly possible, but their reliability and economy might not make the total effort worthwhile. The incorporation of a dc amplifier in the sensing unit, which could be of the Monimatch type, would also allow the construction of an extremely compact sensing unit. It could easily be rf powered directly from the transmission line current flow.

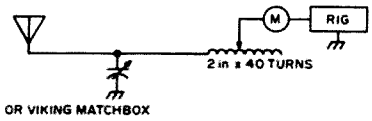
. . . W2EEY/1 ■

Eddy Shell W5ZBC
1209 Holiday Place
Bossier City LA 71010

The Little Wonder: MARK II

While in college this past school year we designed the "Little Wonder" antenna described in *73* Magazine of May 1969. This article brought a flood of mail from amateurs all over the world. Moving from the college dorm back to my permanent home the "Little Wonder" for the most part was discarded in favor of the "Skeleton Cone Antenna" which appeared in *73* Magazine, August 1969. The reader will quickly note the simplicity of the "Little Wonder." The "Little Wonder: Mark II" has the same simplicity, but two added charms: (1) its appearance is more attractive with its scant 7 ft stature; and (2) more important, it has a strong radiation characteristic which is a benefit to any ham on today's crowded bands.

For those who missed the original article of *73*, May 1969, a bit of a review is in order. Two pieces of hard-drawn ¾ in. copper tubing 43¾ and 31½ in., were connected via a coil which was 197 turns of 12 AWG Nyclad close wound on a wooden dowel. The unit was end-fed with a single feeder to an L network or Viking Matchbox and tuned for 1:1 swr.

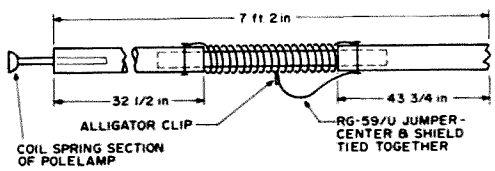


The *Mark II* uses the basic concept of the original "Little Wonder" antenna with four exceptions: (1) the hard-drawn copper tubing is now two sections from a discarded polelamp stand; (2) the low-Q 197 turns of Nyclad wire is now a high-Q BW 3034 coil stock, 2½ in. diameter (8 turns per inch and 135 mH; (3) the *Mark II* is tapped for the band being used; and (4) the antenna can stand anywhere in the room due to the polelamp construction concept.

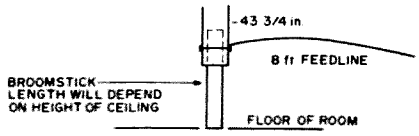
Construction is simple and all parts can be purchased or scrounged:

1 used polelamp or spring-type stand
2 "bar stool" rubber feet
1 BW 3034 coil stock or equivalent (2½ in. dia, 8 turns per inch)
3 6/32 x 1¼ bolts and nuts
1 3 ft dowel rod or an old broomstick
1 alligator clip
1 8 ft single-wire feedline to run from the Mark II to the antenna tuner.

How to construct. The pole stand is cut in two pieces, one 43¾ in. and the second 31½ in. Before cutting the 31½ in. section, press the spring section until the tension is

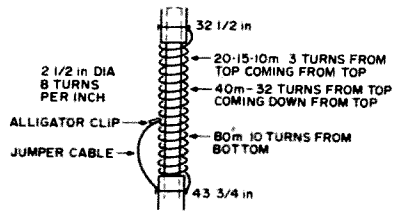


tight. When the spring section is depressed *then* measure for 31½ in. The two sections of the pole stand are connected together via a 1 in. wooden dowel rod or broomstick. The two metal poles are spaced 10 in. apart to accommodate the coil stock. A small hole is drilled in each pipe and dowel so the poles will not slip together and provide for a mechanical and electrical connection for the coil. A second dowel rod is placed in the opposite end of the pole from the spring coil section. The length of the dowel will be determined by



the height of your ceiling. A standard 8 ft ceiling will require a 14 in. dowel. The 8 ft single feedline is connected to the *Mark II* at the same point in which the 14 in. dowel is attached to the pole stand. A jumper wire with an alligator clip attached to the bottom of the coil end is used to short out part of the coil, depending on what frequency you are operating. For 75 meters, the coil is tapped 10 turns from the bottom; 40 meters is tapped 32 turns from the top; and 10 meters are all 3½ turns from the top. The use of an swr bridge and a field strength meter will determine the specific tap for each for each location. Both the east and west coast have been worked on 75 and 40 meters on both a barefoot KWM-2 and the KWM-2 with the SB200.

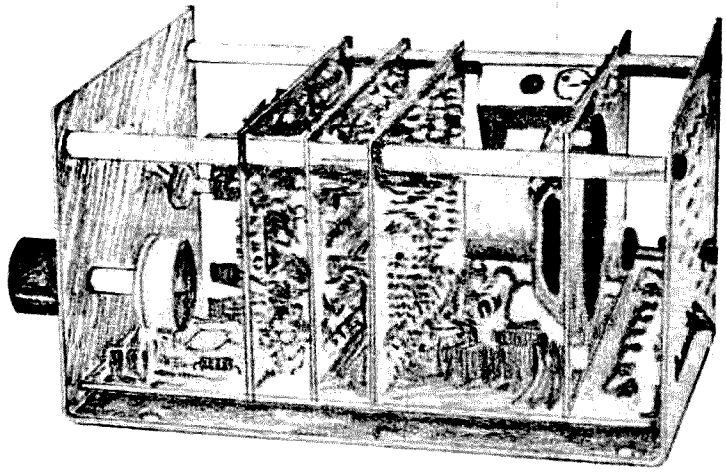
The *Mark II* is tuned in the same manner as the original *Little Wonder*. The equipment is first tuned into a 50Ω load and then connected to the antenna tuner. (Do not tune the rig.) The antenna tuner is tuned for 1:1 swr utilizing 275W Viking Matchbox or L network.



I trust the apartment dwellers will try the *Mark II* and find hamming is still the best hobby of them all.

. . . W5ZBC ■

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Disenchanted with CW? Is the code too old a mode for you? If so, you might be an ideal candidate for ORD's DK-1 digital keyer, a fantastic little package with a brain inside. Believe it or not, the ORD actually makes it fun to send CW.

If you're already sold on CW but haven't yet tried the DK-1, by all means stop in at your nearest radio store and give it a go. This unit is nothing short of fantastic!

With a built-in memory and "interchange" circuitry, the DK-1 "remembers" which paddle was pushed last, even when both the dot and dash keys are activated at the same time. This feature minimizes errors that might otherwise be caused by an operator's inadvertent keying of the wrong paddle.

It shouldn't take long to achieve proficiency on CW with the DK-1, though you may never be able to utilize the full capability of the keyer: a breathtaking 60 wpm. A panel knob allows smooth and continuous adjustment of sending speed all the way down to 7 wpm.

Regardless of code speed, the spacing of and between digital pulses remains at a constant ratio, with the dashes always exactly three times the duration of the dots.

An engineer looking at the guts of the DK-1 might well mistake it for a modern missileborne package. That same high-density, modular-construction approach used in the aerospace industry is employed in the assembly of the ORD keyer. With cover removed, the unit resembles a "card rack"; three circuit cards and the monitor speaker frame are stacked vertically over a "mother board," which contains a transistor-regulated power supply.

The paddle assembly is not included in the purchase price ($130) of the DK-1. To be compatible with the electronics, the mechanical portion must be a dual-contact paddle set. A conventional keying mechanism would also be a handy "extra" for the paddle assembly, since the DK-1 can be keyed on a "manual" as well as "automatic" basis.

The Brown Bros. key set is an ideal choice for the DK-1. It contains precision-machined, adjustable speed paddles as well as an adjacent standard key, all mounted on an extra-heavy cast metal base. Terminal boards on the rear underside of the mechanism make interconnection to the DK-1 a snap.

All in all, CW's a ball, 'cause the DK-1 makes "sending" fun!

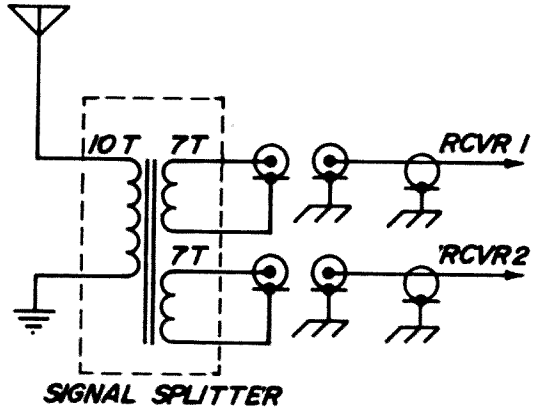
two receivers from one ANTENNA

The classic method of using two receivers on the same antenna is to tie them in parallel directly or use decoupling resistors. But for my money, both methods result in unacceptable compromises in performance. Being a purist, and more importantly, a DXer, a 1 or 2 dB drop in signal can mean the difference between hearing a rare one or not.

As an alternative, I purchased (from Permag Pacific Corp., 5441 West 104th St., Los Angeles, California 90045) a ferrite core, Indiana General CF 108-Q2 ($1.25). This core is good to 50 MHz.

Three trifilar windings of 26 AWG wire were wound on the core, care being taken to space the turns around the core. I then used coil dope to hold them in place. The primary (antenna input) is 10 turns and the two secondaries (for the receivers) are 7 turns each. All three are used for 50Ω antenna and receiver input impedances.

In my case I use two Collins receivers, a

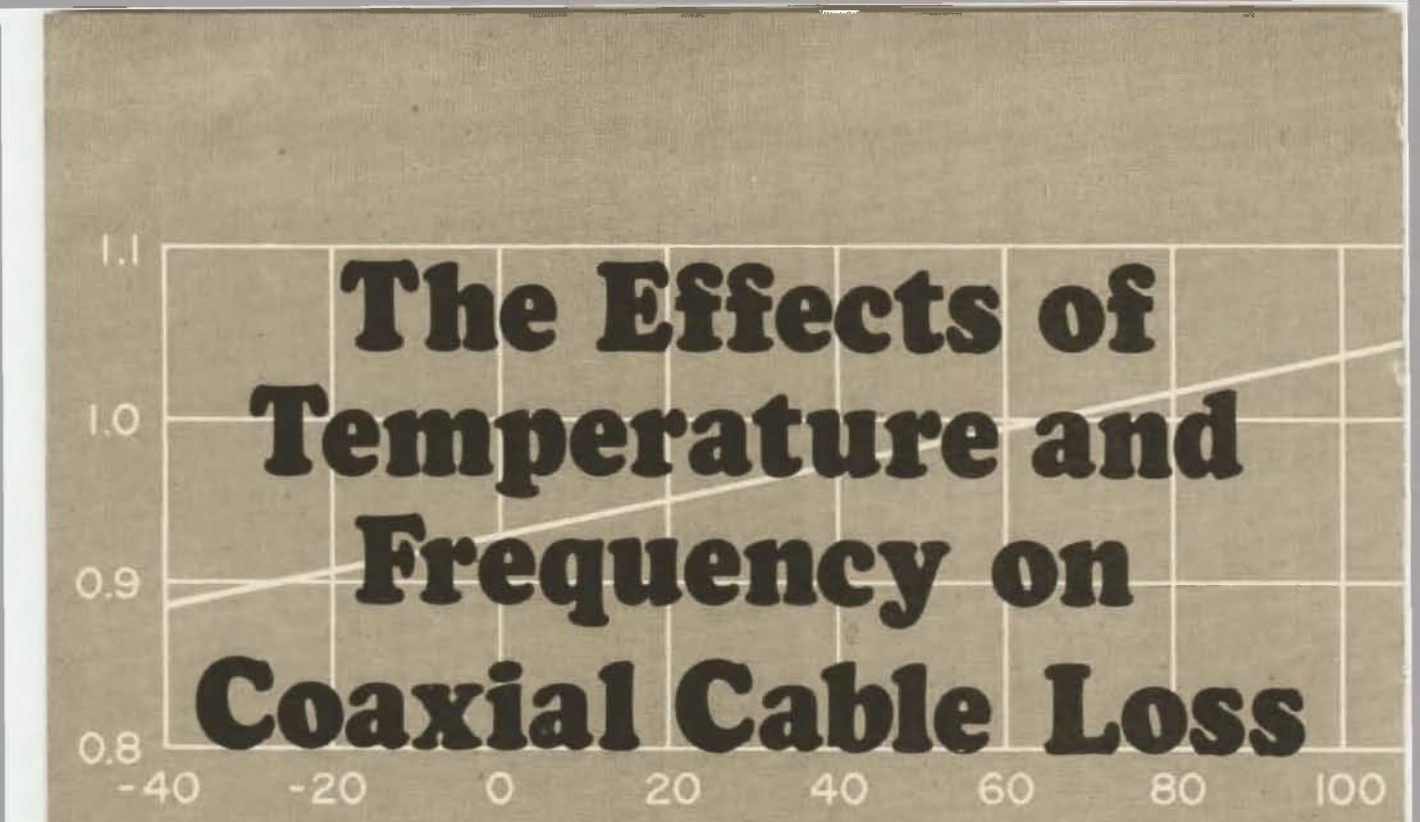


75S3B and a 75S3. No "suckout" or loss is noted on either receiver, regardless of what band either receiver may be tuned to. In fact, no difference in S-meter reading or audio level can be detected from the antenna straight into the receiver or through the toroid.

One caution: If two different makes of receivers are tied together, some loss may be noted. This occurs because of the differences between the two input circuits of the receivers, and it can be corrected by varying the turns ratio of the two secondaries.

In my case, the toroid was mounted in a small Minibox with three RCA jacks on it. It could just as easily mount in the transmitter or one of the receivers. If used with a transceiver and a separate receiver, the toroid must be put in the tranceiver receiver side at the input of the receiver. It cannot handle transmitter directly!

. . . WA6UFW ■



The Effects of Temperature and Frequency on Coaxial Cable Loss

As transmission line temperature increases, so also does loss — and vice versa. Complicating matters, the losses get worse as the operating frequency is raised . . .

Elliott S. Kanter W9KXJ
3242 W. Hollywood
Chicago IL 60645

Perhaps the most common concern of the amateur radio operator is to get the most signal to his antenna with the least possible loss. This has been true since the first spark-gap was heard, and is equally valid today. This fact of maximum power and minimum loss is a prime consideration in both UHF and VHF communications.

There are many factors which will determine the loss or attenuation we might experience in a coaxial cable run. Some are constants but two specific factors are variable and frequently overlooked. These factors are temperature and frequency. Most of us have seen cable charts where the

loss or attenuation in dB/ft is given, but the figures do not reflect the two very important parameters of frequency and temperature.

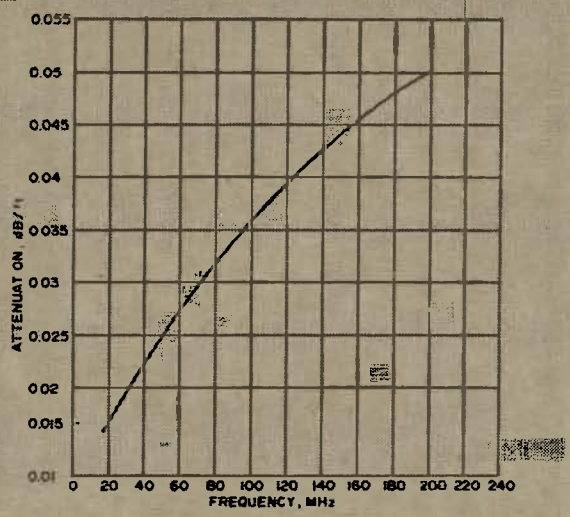


Fig. 1. Signal loss of RG-59/U cable at a temperature of 68°F. Note that loss increases with frequency. The effects of temperature are shown in Fig. 2.

For the purpose of explaining these two parameters more completely, Figs. 1 and 2 were prepared. Figure 1 is a graph showing the attenuation in dB/ft of RG-59/U coaxial cable. If you note the lower scale of this graph, you will find that this graph shows the effects of frequency change on the attenuation. For example, at 20 MHz we can expect a 1.5 dB loss per hundred feet of cable; at 50 MHz a 2.5 dB loss per hundred feet; and at 200 MHz, we note a loss of 5.0 dB/100 ft.

These facts are interesting, but the most important factor is usually ignored. This graph was prepared to show the attenuation of RG-59/U cable at 68°F. Few of us are blessed by living in an area where the temperature is a constant 68° year-round. The midwesterner could expect temperatures of from -40° to +100° in a given year's time. Hams living in the southern states can experience changes of from 40° to 100° in a *single* day. Our graph at 68° is useful, because some basis for measurement must be made, but this does not reflect the various extremes the coaxial cable will be subjected to.

If you dispute the effects of temperature on attenuation, remember the last hot afternoon you operated. Your receiver just wasn't as hot as it was later that night – a

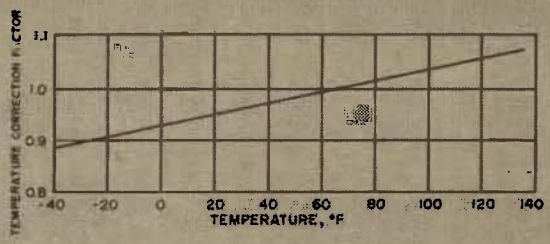


Fig. 2. As the chart shows, coaxial cable exhibits less loss at lower temperatures. To calculate attenuation, the correction factor, determined by ambient temperature, must be multiplied by characteristic loss of cable (Fig. 1).

lot of those weaker stations were lost in the noise. During that day your antenna cable probably underwent temperature extremes from 50° to possibly as high as 120° at mid-day and then back down again.

Figure 2 is a temperature correction graph which will permit you to arrive at the necessary factor by which you can calculate the accurate attenuation loss in dB/ft at any temperature. For example, by consulting Fig. 1 you see that at 20 MHz a 0.015 dB/ft loss exists at 68°F. However, you want to know what attenuation you can expect when the sun is up and the temperature is 100°. By referring to Fig. 2, note that the correction factor at 100° is approximately 1.03. The formula thus tells you that attenuation at 100° is equal to:

1.5 dB x 1.03 = 1.545 dB/100 ft

Similar calculations can be made to arrive at attenuation for lower temperatures as well. Although Fig. 1 was prepared for RG-59/U cable, the correction factor derived from Fig. 2 will apply to any type of coaxial cable you might choose. To make the best use of Fig. 2, you must know what temperature and at what frequency the information in your cable chart was made from. A letter to the manufacturer will usually get this information so that you may make the necessary calculations.

. . . W9KXJ ■

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Brooklyn NY 11227

IMPROVING THE PERFORMANCE OF TRAP-TYPE VERTICAL ANTENNAS

The addition of another element can considerably improve the performance of multiband vertical antennas such as the Hy-Gain 12AVQ or 14AVQ models. The added element can be automatically bandswitched and a transmission line system used which allows simple changeover from an omnidirectional to a directive radiation pattern.

Multiband trap-type verticals such as the Hy-Gain 12AVQ or 14AVQ (or homebrew types) provide many amateurs with a multiband antenna system in a limited space. Provided that a good ground system is used, such antennas can prove to be very effective for DX work. The disadvantage to such antennas is that their radiation pattern in the horizontal plane is omnidirectional. If one is interested in DX in any specific area, it is discouraging to realize that only a fraction of the total radiated power available radiates in any specific direction. One solution to this problem is to use another element with the basic antenna. Such an element should be economical, provide an effective directional radiation pattern, automatically bandswitchable on desired bands, and not require any major change to the transmission line system used with a multiband vertical antenna.

This article describes such an add-on antenna element which will provide automatic bandswitching from 20 to 10 meters, develop a directive pattern with at least 3 dB gain, and not require any change to the transmission line system to the trap antenna. Basically, it is a stub bandswitched element properly spaced from the main antenna and fed in such a manner that the current distribution between the main and secondary antenna is such as to effect a directional pattern on the desired bands. Since the scheme used employs direct feed of the secondary antenna or element, rather than a parasitic-type excited element, it is really applicable to a wide range of multiband antennas including horizontal multiband trap dipoles. Of course, when considering a horizontally oriented antenna, the secondary or add-on element would also have to be horizontally oriented.

Basic Scheme

Figure 1 shows the basic antenna arrangement. Either antenna 1 or 2 can be considered to be the trap antenna and the

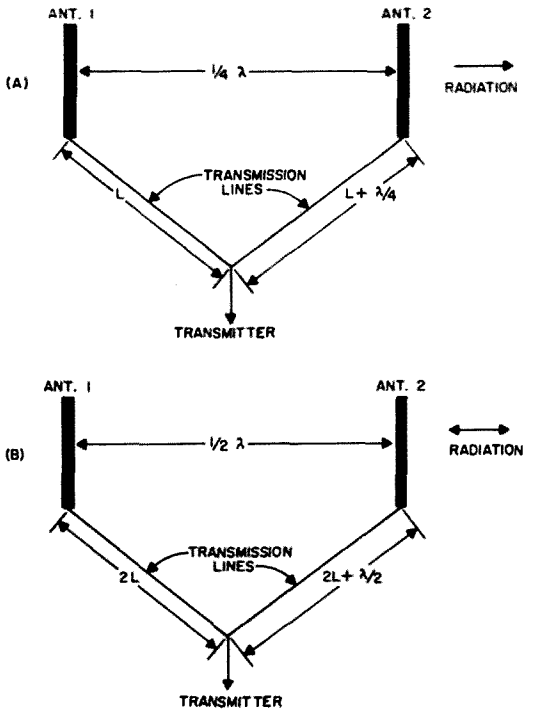


Fig. 1. Two-element antenna spaced ¼λ and fed 90° out of phase (A) automatically becomes ½λ spaced 180° out-of-phase array (B) on second harmonic frequency without changing feedline lengths.

other antenna the secondary antenna. Figure 1(A) shows the antennas separated by ¼λ. The transmission line to the secondary antenna is chosen so that it is ¼λ longer or shorter than that going to the main trap antenna, depending on the direction in which the main radiation is desired. Fed in this manner (90° or ¼λ out of phase) and spaced ¼λ, a cardioid directivity pattern results in the horizontal plane with the direction of radiation as indicated in Figure 1(A). Assuming that each antenna still properly matches its transmission line on the 2nd harmonic frequency, Figure 1(B) shows the spacing and phasing relationships. The antennas are now electrically spaced by ½λ and the one transmission line is ½λ (180°) longer than the other. Under these conditions, the antennas will develop a bidirectional radiation pattern in the horizontal plane as shown by the arrows in Figure 1(B).

The transmission lines are simply paralleled together at the transmitter. This results in a resultant impedance of about 25–26 ohms which the transmitter has to load into, but such an impedance is well within the loading range of almost any transmitter with a *pi* network and variable

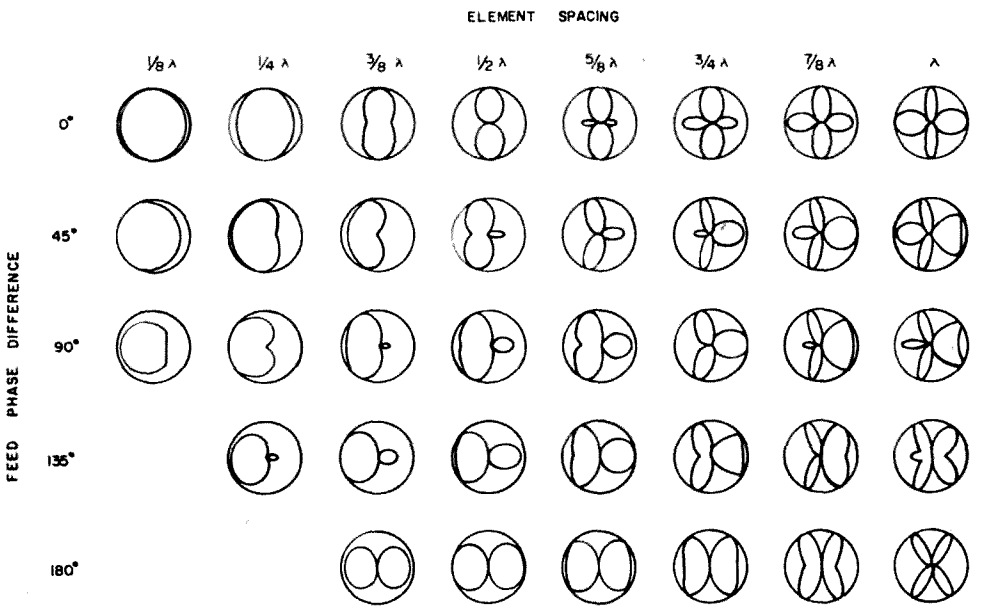




Fig. 2. Besides the usual in-phase (0°) or out-of-phase (180°) current feed systems that appear in antenna designs, a very wide selection of radiation patterns can be obtained by different phasings of two antennas. The patetrns shown are the horizontal radiation patterns. In all cases, the amplitude of the currents to both antennas is equal.

output loading. This is especially true on the higher frequency bands. In order to revert back to omnidirectional operation, the secondary antenna is disconnected at the transmitter and the transmitter reloaded.

The spacings and phasings shown in Figure 1 are conventional ones well known by any amateur acquainted with driven, phased antenna arrays. Many amateurs, however, falsely think that there are only a small number of spacing and phasing combinations that provide useful directional patterns for a driven array with two antenna elements (e.g., ¼λ or ½λ spacing, in-phase (0°) or out-of-phase (180°) feed, etc.). Actually, there are a great many more combinations that can be used, as illustrated in Fig. 2.

From all the combinations shown, it should certainly be possible to develop a useful directive pattern no matter how restricted one may be in the physical placement of the antennas. If the spacing and feedline lengths are chosen correctly, as illustrated in one case by Fig. 1, an effective directional pattern will be obtained without changing transmission line lengths or one or more bands harmonically related to the band for which the antenna array is designed. If there is any difficulty in interpreting Fig. 2, one should first locate the combinations illustrated by Figs. 1(A) and 1(B).

Practical Construction

Figure 3 shows how a secondary antenna was installed with a basic multiband trap vertical in order to provide a directive pattern on both 10 and 20 meters. The spacing and phasing used are those shown in portion of the antenna and the lower approximate 8 ft section acts as a ¼λ vertical on 10 meters. The antenna used was constructed from telescoping aluminum tubing with 1¼ in. o.d. tubing used for the base section. Any similar method of construction can be used but some provision should be made to allow adjustment of the length of the antenna and the stub. The secondary antenna should first be used alone and the transmission line to it checked for low swr (of at least 1.5:1 or less on both bands).

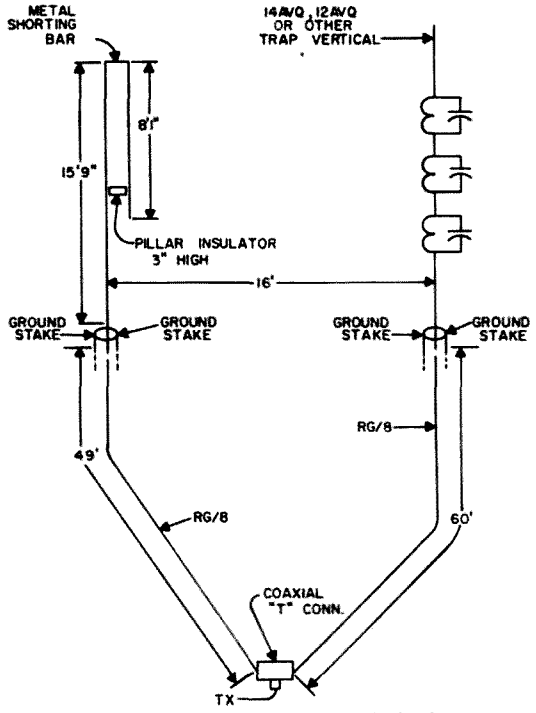


Fig. 3. Secondary stub-bandswitched antenna used with 14AVQ antenna on 10 and 20 meters to form directive array. Feedline system is based on Fig. 1.

The transmission line to the secondary antenna is cut to be ¼λ shorter on 20 meters than the line going to the trap antenna. Note that the velocity factor for coaxial transmission line (.66) must be used when calculating the ¼λ difference in length. The two coaxial lines are joined together via a coaxial tee connector which mounts directly on the coax output jack on the transmitter. For omnidirectional coverage or for operation on a band where the secondary antenna does not resonate, the coaxial plug for the secondary antenna is simply unscrewed from one side of the tee.

Summary

The use of a simple secondary antenna can increase the gain in almost any desired direction by usually 3 dB or more when used with a trap vertical. There is no need to limit oneself to conventional antenna element spacings or phasings. One should carefully study Fig. 2 to decide which spacing and phasing suits a given situation. Then, one can proceed with usage of the secondary antenna in the manner shown for the specific construction example shown in this article. . . . W2EEY/1 ■

Measuring the Difference Between INCIDENT & REFLECTED RF

Bob Eldridge VE7BS
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Vancouver 10, BC

When there is some standing wave on a feeder, the actual reading on your directional coupler doesn't really mean very much unless you keep adjusting the "forward power" for full-scale deflection before reading the scale on vswr.

Generally speaking, you won't go far wrong if you concentrate on tuning your antenna or transmatch for minimum reflected power, but sometimes you may find the "forward power" has suffered by more than the amount by which the reflected power has improved.

On some meters you can watch the forward and reflected scales simultaneously; this is fine if you have the knack of reading two things at once and separating the two facts in your brain, or in effect reading the *difference* between the two readings.

This is the kernel of the whole affair. The only thing that really matters is the difference. True forward power, that is the power transferred to the load, is the difference between *incident power* (power registered on the meter as going forward) and *reflected power* (that registered as coming back). Don't forget that you are really reading *voltage* across the line, so halving the reading represents a 6 dB reduction.

If you want to be fussy, you don't really transfer that much, because some of the incident power is lost on the way up the feeder, and some of the reflected power is lost on the way down. This makes the picture look brighter than it really is.

At HF there isn't much loss in feeders, but at VHF and UHF it is quite a different story. If you have 6 dB loss in the feeder your vswr meter will read a reasonable vswr even if the antenna is quite seriously mismatched at the top of the cable. For example, an antenna with a radiation resistance of 250Ω (vswr of 5 to a 50Ω coax cable) will cause an apparent vswr at the transmitter of only 1.4:1.

Here is a graph which relates apparent to true vswr for various feeder losses. I hope it doesn't depress you.

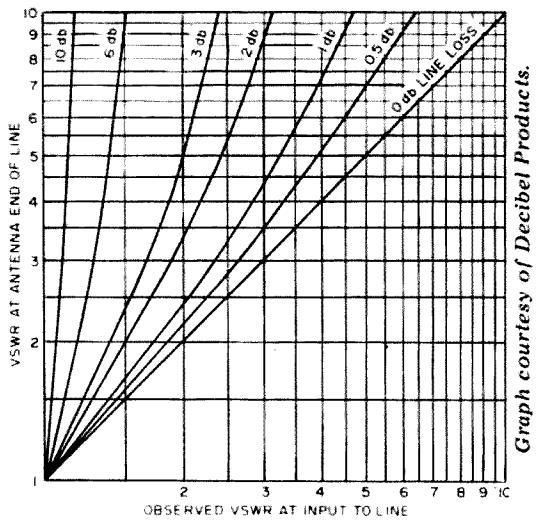


Fig. 1. Curves showing actual versus observed vswr for various line losses.

Tuning Indicator

There is a useful trick in wiring directional couplers (Mickeymatches, Monimatches, Micromatches are all directional couplers):

Close S1 and read incident power.

Close S2 and read reflected power.

Close both and read the *difference*, which is all you need most of the time.

Close them both and the TVI disappears.

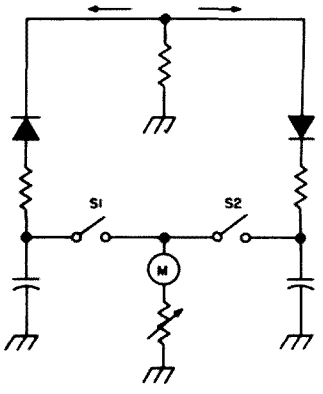


Fig. 2. Reversed diodes can be switched in the circuit to indicate incident, reflected, or "difference."

Note that the diodes are in opposite polarity. Each presents the opposite sign of dc voltage to the meter, and the meter reads the amount by which one exceeds the other. Incident power always wins out over reflected power; it had better, because there is something screwy if more comes back than originally got to the load!

The better the match the greater will be the true forward power into the transmatch.

If you have a short length of coax between the transmitter and the transmatch, and no 50Ω "black boxes" in the line (lowpass filters and the like), it doesn't do much harm if the transmatch cannot transform the feeder impedance down to 50Ω. If the best you can do is tune the transmatch to look like 100Ω, that is fine as long as the transmitter is adjusted to load into 100Ω. Be careful, though, if there are filters in the line, or you may hear your modulation talking out of the black box, and that spells trouble!

. . . VE7BS ■

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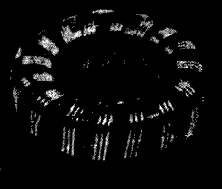
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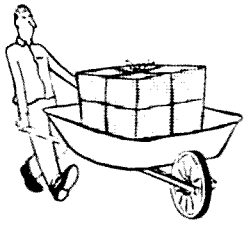
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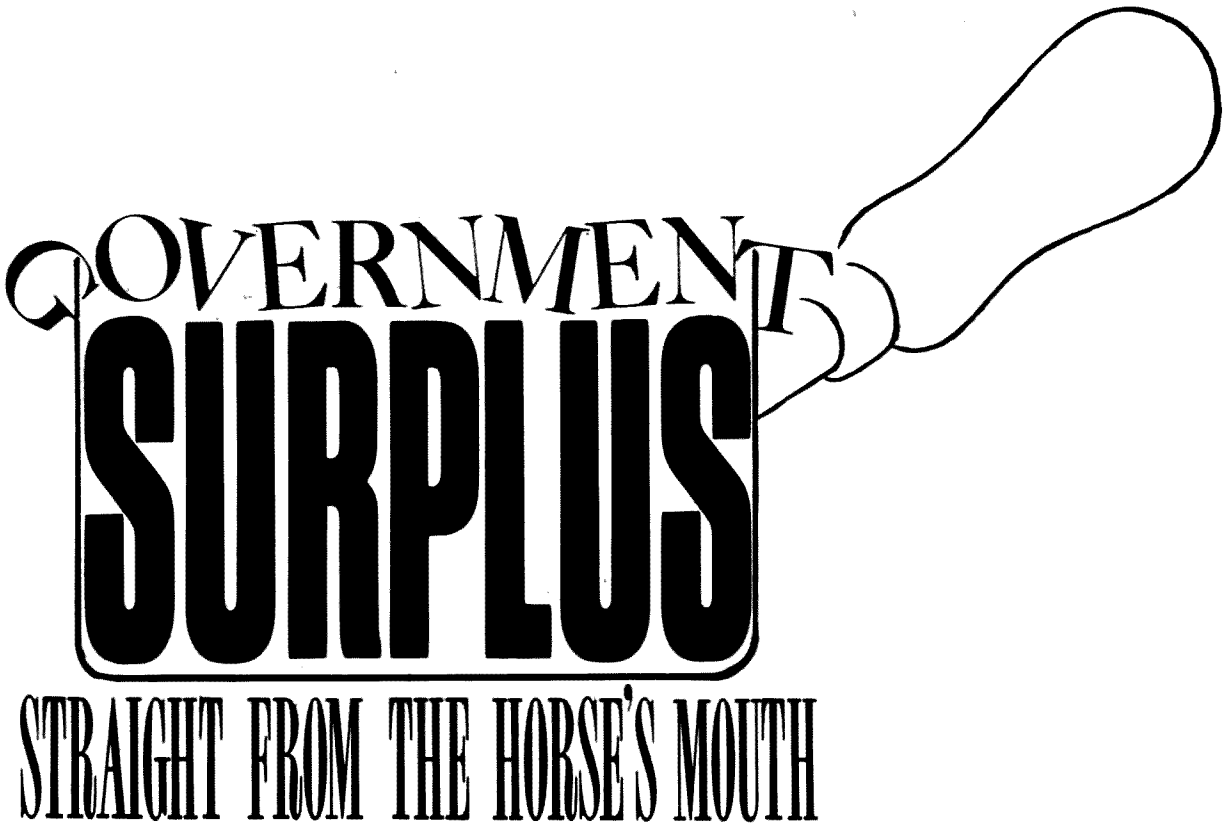
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73 Magazine Peterborough NH 03458

H. F. Smith WA9ANW
4N180 Ridgewood
Bensenville IL 60106



For many years Uncle Sam's surplus electronics have been a gift horse to many hams and electronic experimenters alike. However, in the last few years, good surplus has become increasingly more difficult to locate. Yet, there is one open door to the bargain store. Buy government surplus straight from the horse's mouth!

There isn't anything difficult or mysterious about buying direct from the government. It's simply a matter of knowing who to contact and what procedures to follow in order to buy. Although the government sells as surplus almost any item imaginable, our discussion will be limited to the sale of electronic equipment. All government surplus is sold through two agencies. The Department of Defense sells property belonging to the armed forces and therefore has the most property for sale. Property from all other departments and agencies is sold through the General Services Administration. In the last couple of years, very little electronic equipment has been offered for sale by the GSA. Most of what has been available was airport navigation equipment, although some communications items and some test sets were sold.

Government sales are of the auction, spot bid, or sealed bid variety The latter is the only one that will be discussed here. A sealed bid sale will begin with the receipt of a catalog listing the items for sale. Each item will be described as completely as possible by the office issuing the catalog. But sometimes this is nothing more than the equipment "type designator" number or a federal stock number. Each listing will also contain the quantity offered for sale, whether it is new or used, its condition,

Letter	First Digit	Second Digit	Third Digit
A	Airborne (installed & operated in aircraft).	Invisible light, heat radiation.	Auxiliary assemblies (not complete operating sets).
B	Underwater mobile, submarine.	Pigeon.	Bombing.
C	Air transportable (inactivated).	Carrier.	Communications (receiving and transmitting).
D	Pilotless carrier.	Radiac.	Direction finder and/or reconnaissance.
E		Nupac (nuclear protection & control).	Ejection and/or release.
F	Fixed.	Photographic.	
G	Ground, general ground use.	Telegraph or teletype.	Fire control or searchlight directing.
H			Recording and/or reproducing (graphic, meteorological, and sound).
I		Interphone and public address.	
J		Electro-mechanical (not otherwise covered).	
K	Amphibious.	Telemetering.	
L		Countermeasures.	Searchlight control (inactivated; use G).
M	Ground, mobile (installed as operating unit in a vehicle which has no function other than transporting the equipment).	Meteorological.	Maintenance and test assemblies (including tools).
N		Sound in air.	Navigational aids (including altimeters, beacons, compasses, racons, depth sounding, approach and landing).
P	Pack or portable (animal or man).	Radar.	Reproducing (inactivated).
Q		Sonar & underwater sound.	Special, or combination of purposes.
R		Radio.	Receiving, passive detecting.
S	Water surface craft.	Special types, magnetic, etc., or combinations of types.	Detecting and/or range and bearing.
T	Ground, transportable.	Telephone (wire).	Transmitting.
U	General utility (includes 2 or more general installation classes, airborne, shipboard, and ground).		
V	Ground, vehicular (installed in vehicle designed for functions other than carrying electronic equipment, etc., such as tanks).	Visual and visible light.	
W	Water surface & underwater.	Armament (peculiar to armament, not otherwise covered).	Control.
X		Facsimile or television.	Identification and recognition.

Table I. Equipment Indicator Letters, "AN" Nomenclature System.

(good, fair, poor, or scrap) whether it is packed or unpacked, the total acquisition cost, estimated total weight, and the location of the property.

After you've found an item that looks interesting, it's time to determine the amount of your bid and make an offer to buy it. Several important things figure into this process. First, all items offered for sale are "where is – as is." This means the government does not guarantee that the description covering the item under consideration is 100% correct. (The descriptions I've seen have *usually* been accurate, but they are not guaranteed.) With this in mind, I strongly recommend that you take advantage of the inspection period that precedes each sale. During this inspection period, all items are on display for prospective bidders to make their own determination of type and condition. Dates and times of the inspection period for a particular sale are found in each individual sale catalog.

Most bidders are unable to view the offerings first hand due to the travel requirements and must use the written description and their knowledge of military electronic nomenclature to determine the amount of their bid. I use a list of AN nomenclature (Table I) plus a card file as an aid to bid determination. Another important consideration is the location of the property. The bidder that is awarded the sale is responsible for removal of the property within a specified time, usually

30 days. Unless you can pick up the property yourself, the expense of having a commercial firm pack and ship it will be incurred. This cost should be taken into consideration when determining the amount of your bid. A list of packers and shippers serving the activity where the property is located is available from the office issuing the sale catalog. An item containing but one kind of property is offered for sale on a unit basis with the bidder being required to buy the total quantity listed. An item containing two or more kinds of property will be offered for sale as a *lot*. Property in a lot cannot be separated for bidding purposes. Everything listed must be considered as one unit. In bidding on a lot, a unit price bid is not required. Only total price.

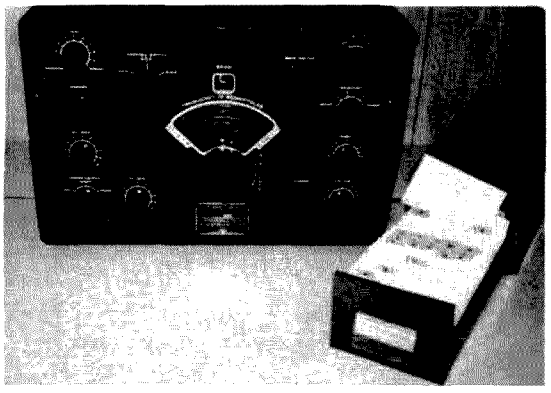
After considering what it is, where it is, and how many there are, you enter your bid on the form enclosed with the catalog. Instructions for completing and mailing the bid form are contained in the catalog and on the form itself, and will not be covered here. The only point worthy of mention is the bid deposit. A deposit of at least 20% of the total amount bid is required to accompany the bid form. In this respect, I have found postal money orders are superior to personal checks. Awards are processed faster when money orders are used and they don't foul up your checkbook when returned from an unsuccessful bid. They are good for five years and can be used as deposits over and over again.

After submitting a bid, three things can happen. You can be outbid, in which case your deposit will be returned. You can be the high bidder and receive the award for the sale. In this case, you pay the balance of the amount you bid and start making arrangements for removal of the property. Or you might be the high bidder and have the government reject your bid as giving them insufficient return. You get the deposit back, but it's very disappointing to be the high bidder and lose. All the bidders participating in a sale receive an award sheet which lists all successful bidders and the amount paid for each item. The sheet also shows which items didn't receive any bids at all and which items were witheld for insufficient return.

Government property is being offered for sale in locations all over the country. The General Services Administration sells through 10 regional offices scattered throughout the country. Each of these offices maintains a mailing list for persons interested in bidding on property located within the region controlled by that office. For a list of regional offices and their addresses, see Table II. Write any office, requesting that you be put on the bidders mailing list. This request will bring a form on which you select the type of property you wish to bid on. Mailing this form back

Geographical Area	Address
Maine, New Hampshire, Vermont, Rhode Island, Massachusetts, Connecticut	620 Post Office and Courthouse Boston 9, Mass.
New York, Delaware, New Jersey, Pennsylvania, Puerto Rico, Virgin Islands	30 Church Street New York 7, N.Y.
District of Columbia, Maryland, Virginia, West Virginia	7th and D Streets, SW Washington 25, D.C.
Alabama, Florida, Georgia, North Carolina, Mississippi, South Carolina, Tennessee	1776 Peachtree Street, NW Atlanta 9, Georgia
Illinois, Indiana, Kentucky, Ohio, Michigan, Wisconsin	219 South Clark Street Chicago 4, Illinois
Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota	2306 E. Bannister Road Kansas City 31, Missouri
Arkansas, Louisiana, Oklahoma, Texas	1114 Commerce Street Dallas 2, Texas
Arizona, Colorado, New Mexico, Utah, Wyoming	Denver Federal Center Bldg. 41 Denver 25, Colorado
Nevada, California	49 Fourth Street San Francisco 3, California
Hawaii	Post Office, Courthouse and Customhouse Building 335 South King Street Honolulu, Hawaii
Idaho, Montana, Oregon, Washington	909 First Avenue Seattle 4, Washington
Alaska	Post Office and Courthouse Bldg. 4th and F Streets Anchorage, Alaska

Table II. General Services Administration Regional Offices.



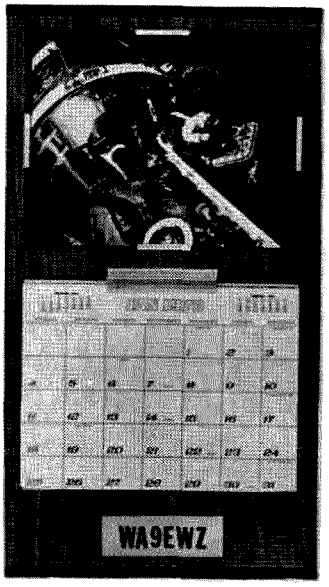
A bargain receiver purchased from the government and the card file the author used to identify it.

to the regional office places you on their bidders list. To be placed on the list for Department of Defense sales, write the Defense Logistics Services Center, Federal Center Building, Battle Creek, Michigan, 49016. This request brings a booklet listing the classes of property sold by the department and a bidder's application form. Fill out the form indicating the classes of property you wish to bid on and the geographical areas in which you wish to bid. When this form is returned to the logistics center, they will place you on the bidders list for the property and areas you have specified. They will also issue you an identification card containing a bidder identification number. Save this card. Your bidder identification number must be placed on all bids you submit.

That covers the highlights on how to bid and how to get placed on the lists. Now you're ready to try your luck. At the start of the article I said that this is one avenue to a bargain. That it is. But not all the time. It's hard to get a bargain when packing and shipping charges are added to the sale price. The closer you are to the location of the property, the better your chances. Another asset is a good knowledge of military equipment nomenclature. If you can identify a good piece of equipment from no description other than the AN nomenclature or type number, your chances of getting a bargain are materially increased. Don't be too upset about repeatedly being outbid. The ones you win will be worth waiting for.

. . .WA9ANW ■

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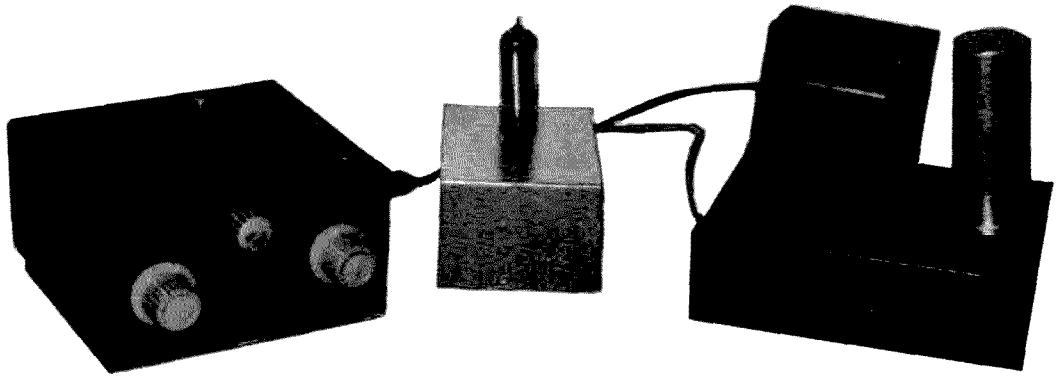
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QRP



Whether you like low power or superlow power, you'll appreciate the simplicity of these two rigs for CW operation on 40 meters.

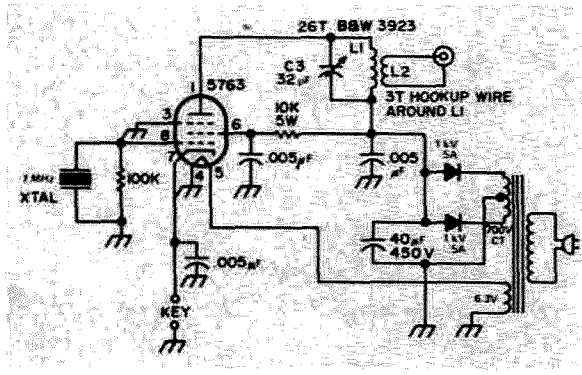
Ever want to try a hand at QRP operation? Here are two rigs that run low power on 40 meters at low cost.

The first rig (Fig. 1) uses a highly efficient 5763 tube and runs about 13W with a 350V supply. The B+ voltage may be dropped down for lower power operation. Almost any power supply delivering about 350V for B+ and 6.3 for the filaments can be used in place of the one shown. Adjust C3 and the position of L2 for maximum output and best keying.

The second rig (Fig. 2) runs about 40 mW with a 9V battery supply. Transistor Q1 can be a GE-1, 2N247, 2SA268, 2N416, or 2N394. Adjust R1, C1, and C2 for maximum output and best keying.

With the 5763 Rig running 13W, I've worked as far as Athens, Georgia (475 mi.) with a 5 x 9 report. Cutting down the power to 5W with a Variac, I worked as far as Syracuse, N.Y. (200 mi.) with similar results. With the transistor rig, I ran some tests with WA3EYL about 2 mi. away. Copy was solid, even when the output power was reduced from 40 mW to only 2 mW.

Doug Pongrance WA3JBN ■



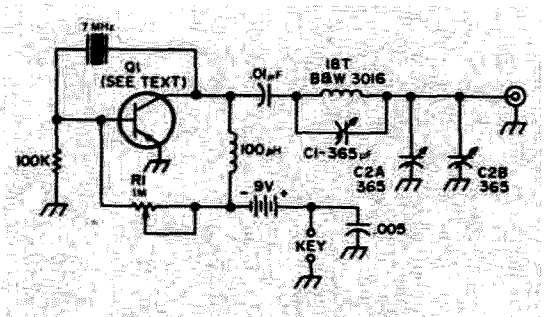
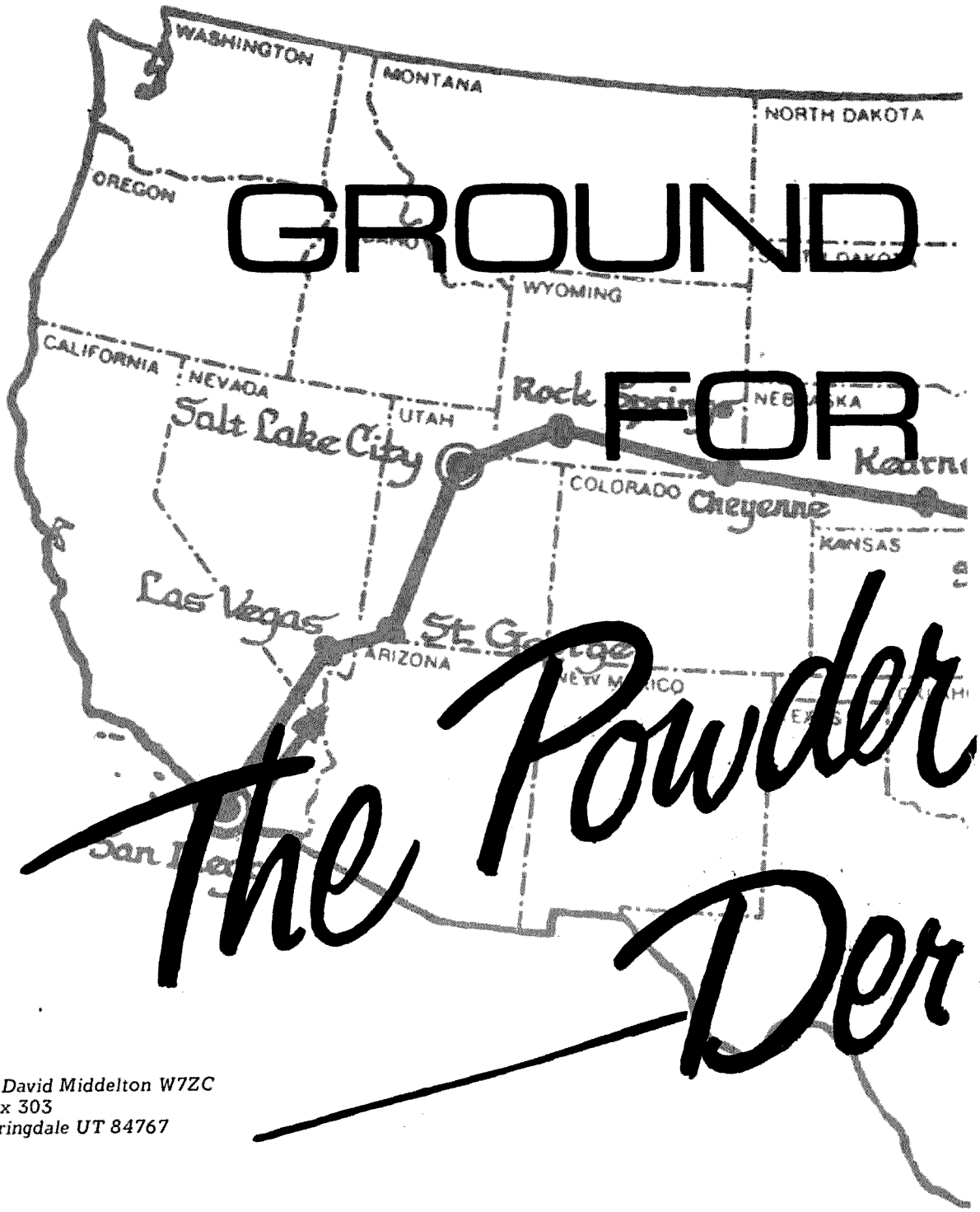


Fig. 1. (left) and Fig. 2. (above)

GROUND FOR The Powder Der



A. David Middelton W7ZC
Box 303
Springdale UT 84767

It is the morning of Independence Day, and Lindbergh Field is socked in – closed. Poised on the San Diego runways are 92 planes all with lady pilots ready to take to the air for the 23rd Annual Powder Puff Derby!

The destination is Dulles Airport, Washington, D.C., over a prescribed 2500-mile route with designated checkpoints and stopovers.

Amateur radio's problem: Relay to race officials, on both coasts, arrivals and departures of all 92 planes at every one of the nine checkpoints along the official route from San Diego to Washington.

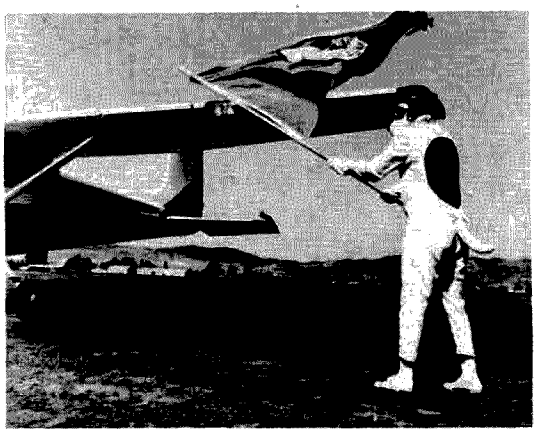
Here is a true account of four days of genuinely worthwhile *communications* by a handful of dedicated ham operators. They sweated, cursed, (as off-the-air "asides"), and battled propagation that ranged from fantastically good to impos-



sible. And they provided a reliable and almost continuous flow of *intelligence* in a 12-station relay back and forth across the U.S.

Time was when the word "relay" was synonymous with amateur radio. Today, there is little or no relaying being done except on established traffic nets. Another facet of old-time ham radio has all but vanished: the requirement for total *accuracy* in the passing of information from one station to another. All thinking people know what happens to word-of-mouth messages: they usually come out well garbled.

The Powder Puff Derby relay network requires total accuracy, without delay, and full cooperation between operators who have no previous experience in working each other. Many are participating for the very first time, though the Derby is an annual event.



Honorary Starter "Snoopy" waves off first of the 92 planes in the '69 Powder Puff Derby, with the flag bearing official San Diego bicentennial emblem. (Who's Snoopy? – Ruth Ebey of San Diego.)

By the time the fog lifted at San Diego and the planes were cleared for takeoff, three of the entries had been scratched. But the 92 did get under way, and the radio operation swung into action.

At first, things were confused and hectic, as is often the case with such ambitious undertakings. An FAA official called, via ham radio, to ask how many planes had bypassed St. George. Such a question might be perfectly normal, but it had been asked before the race had even started. Once the gals were airborne, though, radio traffic began to fall into something of a routine.

Nervousness settled over race officials as well as members of the communications net when, 12 hours after the planes had departed, one of the contestants was unaccounted for. A concentration of cooperative effort within the framework of the nationwide network managed to turn up the elusive missing plane, and the net secured for the night. The first leg of the race had ended with no casualties and no critical problems. But that was just the first day.

The second day was no more than a few hours old when, from W7LYV, came the report: "Plane down and burning near Jacobs Lake, near the north rim of the Grand Canyon."

Quickly, the net control station passed the word that the downed plane was *not* one of the Powder Puff Derby contestants, although it was in the general path of flight. The ham who originated the call, W7LYV, alerted the Federal Aviation Agency and the Arizona highway patrol, but the net control station kept the message from being relayed east of Salt Lake City. No need to pass traffic that was not pertinent to the race, the reasoning was; and besides, like any message, news of an accident, even though unrelated to the Derby, could be misunderstood or misinterpreted at subsequent checkpoints, resulting in needless confusion and concern.

When the emergency traffic had cleared, the network bustled with routine messages going both ways along the route; thousands of bits of information were passed from one point to another. The planes began together, but now they were strewn in the air over the entire flight route; and the communications had to cover the complete range – from the area of the first femme pilot to that of the last. The network was alive with traffic all right; but it was organized, tersely worded, efficiently passed.

All afternoon and evening of July 6, radio and TV weather reports indicated rapidly deteriorating flying conditions in the midwest, with a bad front moving into the central and eastern portion of the U.S. The racing ladies were heading directly into very bad weather! Many set down and stayed put in various locations to avoid flying into the storm!

As the net ended its second day, all planes but one were once more accounted for. The FAA was alerted, and an official follow-up would provide data on that last elusive straggler.

The results of the first two full days of the Derby Relay Net indicated a splendid spirit of cooperation, a high order of discipline, and an intense interest on the part of not only the relay members but by nonparticipating amateurs as well, many of whom called in to briefly express an interest in the race and in the net. W6OII at Carmel, Calif. performed yeoman service policing the 40 meter frequency of oper-

ation during these first two long days of this hectic communication problem.

Problems

The weather was bad in the midwest and east as the third day began. Severe storms raged over all the route east of St. Joseph, Mo. At 1920 GMT, WØQOQ reported from Kearny that all planes were still on the ground. Not one of those sensible gals chanced a takeoff in the face of that storm!

Then that seemingly inevitable result of all huge nets happened. The messages became increasingly contradictory. Here is the log for the afternoon of the third day.

1423Z – WØNH reports via relay that 13 planes have departed but 9 still left at St. Joseph.

1432Z – W9JLL tells W8VA that planes 24, 14, and 21 departed Mt. Vernon. The ladies are moving east again!

1438Z – K7FCN says his two birds still on ground at SLC. No one knows why the delay.

1445Z – K7FCN breaks in to say that one plane is in the air and one on takeoff strip. This clears SLC of all his planes.

1447Z – Plane 21 had been scratched prior to the start of the race; yet it kept showing up in checklists. A critical look is taken at information sources and word goes out to correct and prevent such errors.

1529Z – WØQOQ says that NO planes have departed Kearny.

1543Z – WØQOQ reports that No. 8 departed Kearny on a "special V F R" after much deliberation between Kearny and San Diego regarding race rules.

1546Z – W7ZC reads W8VA, Huntington, directly (W8DUV, YL Kay, operating).

1640Z – WA7DUG, Fran, Las Vegas, checks into net. (She was to be active and a great help in checking racers' locations during the remainder of the race.)

1701Z – Plane 40 arrives at Dulles Field, the terminal point.



Marilyn Copeland and Pat McEwen, both of Wichita, Kan., ready to board Pat's snazzy checkered racing Beechcraft Bonanza V-35A.

1720Z to 1817Z – Scores of arrival and departure times relayed by stations east and west of Kearny as the racers move eastward.

1817Z – The RONS (required overnight stays) for the third night begin. And planes are scattered!

1956Z – WØQOQ sends W9JLL a request to determine accurate list of *arrivals* at Dulles, but no information was received in reply to this formal request.

The conflicting reports and incompleted message loops raised questions among the responsibles of the communications networks. And at 2013 GMT (or Z), W6KBT, the western net control station, suggested that all stations furnish "modus operandi" of relay station setups along with lists of participating personnel. It stood to reason that if the net operation was to be smoothed in future efforts, the place to begin was in the organization. Mailed questionnaires would be put into circulation after the Derby.

Meanwhile the gaps in the relay net were widening and difficulty was mounting in handling data from the midwest across to the west coast. And still no word on arrivals. At 2050, a message from W6KBT to destination stations K4EAM, W8VA, and W9JLL: "Imperative expedite arrival times your station". Still no reply. The net control kept pressing W7ZC to obtain



"Granny" Maybelle Fletcher, pilot, and Jackie Kelly (copilot not shown) made a fetching pair in their red dotted tops and tattered minis.

information from the east regarding arrivals. For some reason, information seemed to be flowing to the east but little data flowed from the east to the west.

Eventually, the long list of arrivals at Dulles was received in the west directly from WØQOQ by W7ZC. The Kearny station was the sole remaining link between east and west. Relay possibilities east of Kearny were scant; clearly, a communications breakdown had developed along the last leg of the route.

The snafu continued the following day. Western station W7ZC made repeated all-out attempts to establish contact directly with *any* Washington, D.C. station, irrespective of its net participation. Dozens of calls made on all modes and frequencies yielded no response from the Washington area!

Finally, at 1830, W7ZC raised W3NY, near Washington, and explained the situation. W3NY, unable to raise K4EAM, managed to make contact with a Huntington station. Thus, the net stepped out of the net to maintain a flow of communications. Through a series of schedules, W3NY passed additional data updating the location of racers.

There was no explanation of the failure of all other Washington area stations to reply to W7ZC's repeated directional calls, particularly in view of the fact that W3NY reported the western station's signal was consistently loud and clear.

Even though not a smashing success, the Derby relay net worked! The team had successfully moved traffic efficiently and accurately across the U.S.

There were a few unsatisfactory conclusions. Information is still unavailable as to why Dulles did not originate and forward more data to the western race officials, via the relay. Information from Dulles was frustratingly sparse, and especially on the last day.

In spite of the communications blackout in the east (or boycott), the event spoke well for the amateur fraternity. Had it not been for the fine cooperation of non-net W3NY, and the continued activity at W8VA, W6KBT (who was being queried by race officials) would have been left without any news.

Word reached W6KBT after the relay that K4EAM operated under a severe handicap due to station location and a poor antenna. And, of course, the complete lack of any transcontinental circuit severely hampered net operation.

On July 3, 1970, the 24th annual Powder Puff Derby will begin from Monterey Peninsula Airport in Northern California. As the damsels make their 2760-mile trip to Bristol, Pennsylvania, the ground-based observers will again be looking to the amateurs for their communications support. Will they get it?

Possibly! Here's some insurance measures:

1. Establish a *trunk* system, with relay terminal stations *not* located *at* the Race airports, but with these stations serviced by "drops" from the airport. These "drop" circuits should be on a different frequency from the net itself, preferably on VHF FM. This method was very successfully used at several stations along the relay.

Placing stations *away* from airports would permit *better* installations and antennas due to restrictions enforced by airport communications managers.

2. Establish adequately equipped and manned stations (with CW and SSB facilities) plus suitable antennas and operations space, for totally reliable communication along the net system. Redundant or at least multiband equipment is desirable. Each relay station must have *total* communication with the stations in both directions.

Though it is not necessary for a relay point to be able to communicate with stations beyond the next one, it is highly desirable – as proved in 1969 when communications was maintained across wide gaps because of poor conditions or other reasons.

Emergency power may well be a requisite, especially at key points! Mobile units might provide such links if the system chain is broken.

All stations should be capable of operating at their maximum potential, as this is badly needed when QRM, QRN, or propagation causes difficulty.

Station planning must be done *in advance.* Jury-rigged antennas and facilities prove a handicap to the system.

3. Alternate frequencies should be predetermined, preferably in the lower ends of the bands (less QRM) by providing upgraded licensees and equipment. At many points difficulty was had in finding *any* reliable operators. A few upgraded licensees *did* take time and have sufficient interest to be valuable to the net's operation.

4. Establish better liaison between race officials (having data) and operators at relay points. This is a matter for race officials working with net personnel.

At each western station, operators were ready, able, and willing to do their job without delay. In some locations it appeared that race officials were indifferent or were uninformed as to the net's purpose and availability, resulting in a delay in passing information.

It is clear that the prime consideration is the safety of the pilots and crews – that the transmission and reception of arrivals and departures is secondary. However, this "flying safety" may require accurate updated information in the event of a mishap.

The amateur operators were aware of this and did expeditiously handle all information given them. But it was not charged to the net.

The Powder Puff Derby relay net is a *service* operation and all who participate should take cognizance of this fact. Net responsibilities include the establishment of suitable equipment and operational facilities to maintain solid communication back and forth across the country in order to handle data supplied by race officials.

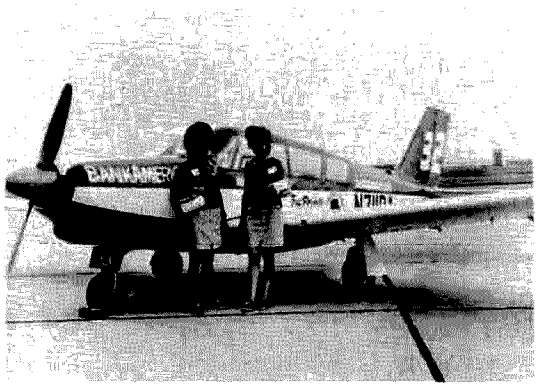
It follows, therefore, that race officials should extend the same full spirit of cooperation to the amateur radio operators so that the fullest utilization may be made of far-flung net talent.

Now. What about that Powder Puff Derby coming up? Where and how do the misses and Mrs. fly?

On July 3, the 24th annual Derby will take off from Monterey Peninsula Airport in Monterey, Calif.



Safe and sound all the way from San Diego to Washington, D.C. Crew #55 from San Jose, Calif. are greeted by pilot/author and president of National Aviation Trades Association, Frank Kingston Smith. (At controls) Layne Hackett, "Cumulus" held by Betty Hicks, world famous golfer. (No dog-sitter could be found so Cumulus had to race, and loved it.)



It's Fess Parker's Piper Comanche PA-24; this team flew in the coast-to-coast dash, "Daniel Boone" himself capped the pilots of #32 just before takeoff. L. (Copilot) Billie Herrin.; R. (Pilot) Margaret Mead, winner of the Derby in 1968.



"Snoopy" on Louise White's Mooney Super 21 might have had a rough ride, but pilot Louise looks cool and relaxed after arrival at Dulles, although thunderstorms plagued the last half of the race route.



K7UGA Harmonic. – *All hail the happy winner of the 1969 Powder Puff Derby, as Congressman Barry Goldwater, Jr. hands her the trophy at the awards banquet held at Marriott Twin Bridges Hotel, Virginia.*

The race is open to all qualified women pilots flying stock model, fixed-wing, single or multiengine aircraft. As always, only daylight flying in VFR (contact) weather, as defined by the Federal Aviation Administration, is permitted. Winners are determined on a handicap basis, "par speeds" having been established based on figures available from manufacturers' data for each make and model of aircraft. Since takeoffs are in order of entry, winners cannot be known until all planes have crossed the finish line.

Climbout will soon take them over the fruited farms of Fresno, first of the 10 *en route* stops officially designated for refueling and remaining overnight. Stop towers will be equipped with Simplex time stamps so that after the flyby of the timing lines, time will not be counted in the final scoring until the wheels start their takeoff roll on the runway.

Racers will point their noses into the blue to clear Mt. Whitney's 14,000 foot peak. They will overfly the blinding gleam of Death Valley before letting down into star-studded Las Vegas. Eastward, they'll flash over the desolate beauty of a last frontier with its intricate spires and serrated ridges, the brilliant red sandstone of the Valley of Fire, and the goosenecks of the river canyons, to arrive at the foot of the penetrating blue, serpentine Lake Powell at Glen Canyon Dam and Page, Arizona.

Continuing along the north rim of the mighty Grand Canyon, contestants will enjoy unlimited visibility encompassing Zion National Park with deep purple gorges, sculptured Bryce Canyon, Rainbow Bridge – "one of the seven natural wonders of the world," Monument Valley with its red cliffs, and volcanic Shiprock before arriving at booming Farmington, New Mexico, "Energy Capital of the World."

From here it's still high country with a let-down over the Navajo Trail for a *must* flyby at Johnson Field in Walsenburg, Colorado, before heading for a *must* stop at Peterson Field, Colorado Springs in the shadow of 14,000 ft Pikes Peak. Desire to linger in the Garden of the Gods, red monoliths scattered among green fields, and at the architecturally beautiful Air Force Academy, must be denied with the longest leg still ahead: 375 miles into Hutchinson, Kansas. From this prosperous

city, contestants may press onward without oxygen if lower winds are favorable, to revisit Springfield, Mo., then into the business hub of northwestern Tennessee, Dyersburg. A high welcome awaits the racers at this mandatory stop.

Then it's a takeoff on a northeast heading for historic Louisville, Ky., which combines midwestern vigor with southern charm.

Off and upward the racers will press to Morgantown's splendid airport set atop one of the verdant hills of West Virginia.

The final lap is a hurdle over the sprawling Allegheny Mountains into the 3 M Airport, Bristol, where the Pennsylvania Turnpike Bridge over the Delaware River connects Lower Bucks County with New Jersey. Here, atop their tower, the timers will click off the final seconds for each plane as its crew flashes past the glorious orange finish line, salute to a challenge accomplished.

Contestants will be vieing for the $5,250 purse to be divided among the top five winners. Trophies will be given, as well as several thousand dollars more in additional prize monies for the best scores between stops, best in each horsepower class of aircraft, and in other specialized categories.

The racers will help Monterey celebrate its bicentennial. Sponsoring the start is the Monterey Bay Chapter of the Ninety-Nines. The terminus is being sponsored by the Eastern Pennsylvania Chapter of the Ninety-Nines.

And for the 18th consecutive year, the radio net will be furnished by ham radio.

Considering the checkpoints between the two terminal points, the total ground distance covered, and the very large number of people participating, it is truly no wonder that two-way coverage gets to be a problem at times. But improved procedures and a determination by conscientious amateurs will combine to make the next Derby the most successful of all.

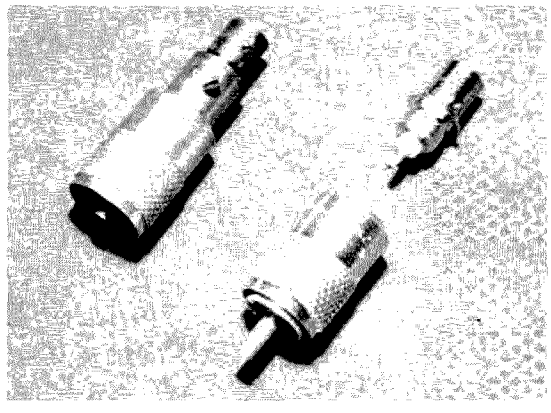
The author wishes to acknowledge the contributions of Kay A. Brick, Chairman of the board, All-Woman Transcontinental Air Race, Inc., Teterboro, N.J. . .

. . . W7ZC ■

COAX ADAPTER VHF to BNC

Many new converters, SWR meters, and other accessories are now coming out with the newer BNC coax connectors on them. Most hams have been using coax equipped with the PL-259 plug or similar larger size connector. A simple, easily-constructed adapter can be assembled as follows, at a cost of approximately 75 cents according to current "bargain-counter" prices. All that is needed is one PL-259 plug and one UG-1094/U. The latter is the BNC type also known as UG-625, and is the single-hole chassis-mount version.

Drill and tap the neck of the PL-259 3/16 inch from the end with a 6-32 thread, and fit this threaded hole with a flat-head screw. Solder a piece of 16 or 18 AWG wire to the center pin of the BNC fitting, cutting it long enough to extend through the center pin of the PL-259 when the BNC fitting is inserted into the neck of the PL-259. The BNC fitting has a flat on its threaded surface; tighten the setscrew against this flat, and solder the wire to the center pin of the PL-259.



The photograph shows the "before and after" views of the assembly. This makes a sturdy, short, convenient adapter, and takes ten minutes to assemble, preventing loose, haywire lash-ups.

Herbert Sandstrom, Jr. W9MEV ■



21 dB of gain on 2 meters with a new approach to the construction of VHF beams

by A.H.C. Smirk, B.E. ZL4TAH
(Reprinted from Break-In)

Introduction

Of all the components making up a VHF installation the antenna offers the most potential for improving a station's capability. For those who may have doubts it is pointed out that with the low-noise transistors available today, such as the MPF107 of the field-effect type, it is relatively easy to obtain a good noise figure; however, the overall noise figure of a VHF receiving installation is affected by the gain of the antenna. The improvement that can be obtained by increased antenna gain depends only upon the size of array that it is practical and economical to construct.

In recent months I have developed a suspension system for VHF antennas where the rigid booms and structural framework of the conventional high-gain antenna are replaced by ropes under tension. With this system it is easy to construct very long yagi antennas which individually have the same gain as stacked arrays of conventional design.

The 32-element yagi described in this article has a length of 73 ft, a theoretical gain of 21 dB, and can be constructed from all new materials for less than $10. Photo 1 shows a completed 32-element beam before it was raised onto its masts. Antennas of this form could properly be described as suspended long yagis and I suggest that they should be called "sly" beams, using initial letters to form the acronym.

Electrically the sly beam is identical to a rigid boom yagi of equivalent length except that the elements are slightly shortened to compensate for the removal of the usual metal boom.

Suspension Cords

Ordinary cotton or hemp rope is not satisfactory for the suspension cords as these materials absorb water into their fibers resulting in swelling and shrinking. Furthermore, the length of such ropes depends upon the period for which they have been subject to load, a phenomenon known as "creep." For any VHF antenna it is a fundamental requirement that elements must have the correct spacing at all times when the antenna is in use. Nylon cords generally do not absorb water into the fiber, but some types will hold water by capillary absorption between the fibers. A 120 lb breaking strain fishing line made of "Ulstron" fiber has been found to have adequate mechanical properties. (It is New Zealand made, so may not be readily available in all areas. But parachute cords, deep-sea-fishing lines, and other high-strength nonporous cords should be equally suitable.)

Elements

With yagi antennas the directors may be all of the same length or of decreasing length with distance from the driven element. In the former case the optimum length for all director elements depends upon their total number. When there are more than 12 in number, the length of directors becomes less than 36 in. for a design frequency of 144.2 MHz. Aluminum welding rod of 1/8 in. diameter is supplied in 36 in. lengths and is a ready source of elements. The low-cost, lightweight and high-conductivity characteristics of aluminum make it an ideal material. For the driven element and reflector which are necessarily greater than 36 in. long at 2 meters, solid brass rod of 1/8 in. diameter has been used. It is available in long lengths from suppliers of nonferrous metals. The lengths and spacings of all elements for the 32-element sly beam are given in Table I.

Matching

Most of the usual forms of impedance matching should be satisfactory with the sly beam. I used a 300Ω delta match at the driven element and a length of 300Ω slotted, balanced TV feeder to a fully adjustable balun at the transceiver. To some, this system may seem a bit crude but it does contribute to the overall simplicity of the antenna. Results using the delta match are very satisfactory and checks made with an impedance bridge confirm that a good match is obtained at the driven element. When using balanced line it is necessary to keep the line taut, otherwise some fluctuations in forward and reflected power may occur with movements of the feeder. Details of the delta match are given in Diagram 1.

All directors – cut from 1/8 in. diameter aluminum welding rod.
Driven Element and Reflector – cut from 1/8 in. diameter brass rod.
Spacing of Fiber Cords – 14 in.
Design Frequency – 144.2 MHz

Element	Length, in.	Spacing from Preceding Element	Spacing from Driven Element (in.)
Director			
1	35.2	6.6	6.6
2	35.2	7.4	14.0
3	35.2	7.4	21.4
4	35.2	16.4	37.8
5	35.2	31.9	69.7
6	35.2	31.9	101.6
7	35.2	31.9	133.5
8	35.2	31.9	165.4
9	35.2	31.9	197.3
10	35.2	31.9	229.2
11	35.2	31.9	261.1
12	35.2	31.9	293.0
13	35.2	31.9	324.9
14	35.2	31.9	356.8
15	35.2	31.9	388.7
16	35.2	31.9	420.6
17	35.2	31.9	452.5
18	35.2	31.9	484.4
19	35.2	31.9	516.3
20	35.2	31.9	548.2
21	35.2	31.9	580.1
22	35.2	31.9	612.0
23	35.2	31.9	643.9
24	35.2	31.9	675.8
25	35.2	31.9	707.7
26	35.2	31.9	739.6
27	35.2	31.9	771.5
28	35.2	31.9	803.4
29	35.2	31.9	835.3
30	35.2	31.9	867.2
Driven Element	38.4		
Reflector	43.0	12.3	20.5

Note: The reflector spacing has a slight effect on the radiation resistance of the driven element.
If maximum front-to-back ratio is required the length of the reflector should be adjusted while making actual measurement.

Table I. Dimensions and spacing for 32-element sly beam.

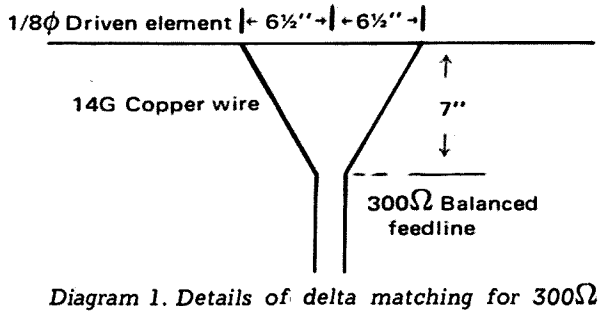


Diagram 1. Details of delta matching for 300Ω balanced feedline.

Fabrication

Even with the best artificial fiber cords available a small amount of creep inevitably occurs. A standard technique to minimize this is to prestretch the cords for 24 hours at about 90% of the breaking load. This is well worthwhile as about 80% of the ultimate creep will occur within the first few hours of loading, leaving only a small percentage to occur while the material is in service. The prestretching is conveniently done by placing two of the cords in parallel ready for the elements to be fixed and then tensioning between anchors as prescribed.

As an additional safeguard against creep it is recommended that when the sly beam is not in use the tension on its supporting cords be reduced to less than 50% of the working load. In practice, this is easy to do and only requires that the supporting cords pass through a pulley at the mast head and down to some convenient point from which adjustments can be made.

Two light wooden spacers about 15 in. long are used to maintain the cords at the correct spacing. These can be fixed to the fiber cords by passing the cords through small holes drilled near the ends of the spacers and then knotting the cords about the spacers.

It should be noted that the supporting cords are slightly elastic so that the spacing of the elements depends upon the tension applied. Also the sag of the array and susceptibility to lateral displacement in high winds is affected by the tension in the cords. It has been found that a total of 80–100 lb of tension in the antenna is satisfactory for a system employing two cords each of 120 lb breaking strain.

The elements should be cut to size and fitted to the supporting cords while they are subject to the intended working tension. Many methods of attaching the elements to the supporting cords are possible. However, wire ties should be avoided because of the risk of producing noise in the receiver due to the interaction of the unbonded metals. The simplest approach is to tie the elements firmly in place with a piece of cotton fishing line as shown in Fig. 2.

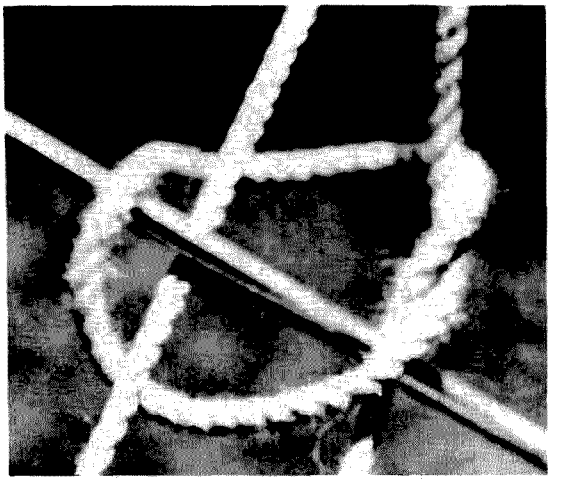


Fig. 2. Knot used to fix elements to suspension cords.

It is useful to arrange the knots so that they can be slid along the fiber supporting cords. The first step then is to tie all the elements in place and then working from one end slide each element into its exact position. A measuring stick with the leading dimensions marked on it simplifies this procedure. Knots are then trimmed and a drop of glue or varnish applied to hold them.

Masts

Two supporting points are required, one at each end of the array, and each of these must be capable of taking up to 100 lb of sideways loading. This sounds difficult but in practice is not really so. Use can be made of trees, chimneys and other natural objects although care is necessary to insure that the antenna's performance is not affected by objects within its effective aperture. If a tree is employed some arrangement is necessary to compensate for sway; otherwise the element spacing will vary. One solution is to use a pulley at the treetop and a counterweight which may rise and fall in a setup similar to that used for low-frequency longwire antennas. Even if two masts are required the cost need not be excessive. I used masts of 1½ in. galvanized pipe with three guy wires at every 10 ft of height. The guys used are

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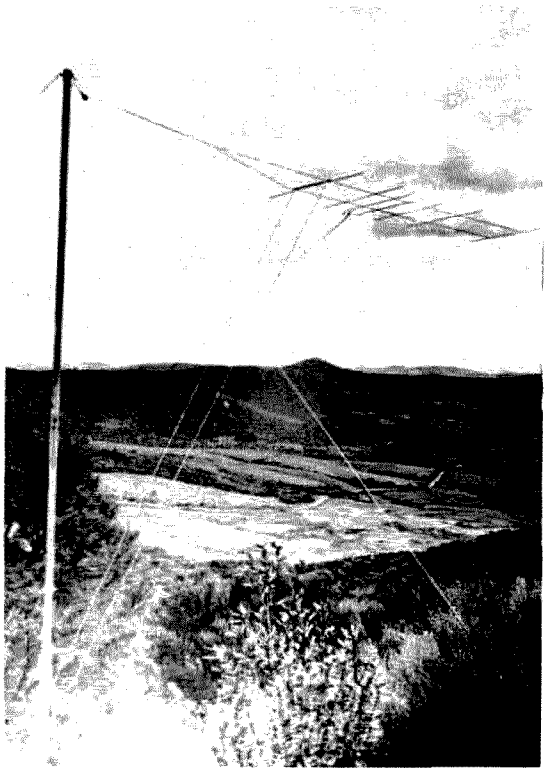


Fig. 3. The launching end of the "sly" beam.

10-gage fence wire, each fitted with a wire strainer for easy tensioning. With this arrangement there is no difficulty in obtaining the necessary 100 lb lateral load ability at 40 ft above ground, provided the guy anchors are firmly set.

Polarization

With the arrangement shown in Fig. 1 the two fiber cords are brought together to form a single cord at each end of the antenna. Generally the weight of the feeder is sufficient to keep the elements horizontal but in windy conditions the antenna may rotate, thus altering the plane of polarization. A simple solution is shown in Fig. 3. Two light cords are attached to the wooden spacer at the reflector element to maintain the desired plane of polarization of the array. A change from horizontal to vertical polarization or vice versa can be effected in a few moments by altering the relative positions of the two stabilizing cords thus rotating the array about its long axis.

Bandwidth

Generally speaking, the bandwidth of a yagi antenna is inversely proportional to the gain; for a 21 dB yagi, peak performance can only be expected over a narrow portion of the band. As normally defined, the bandwidth of the 32-element sly beam is probably about 0.5 MHz at 2 meters. Outside this range a noticeable drop in performance is expected. However, the sly beam has an unusual feature not found in conventional antennas: The supporting cords are quite elastic and by altering the tension on the beam it is possible to alter the spacing between adjacent elements. This *en masse* altering of element spacing tunes the array and has the effect of increasing the useful bandwidth of the antenna. It should be pointed out that to achieve maximum gain at a particular frequency the spacing between every element and the length of every element must be optimum.

Gain

Some authorities do not state performance figures for antenna arrays because of the uncertainties involved. However, I consider that an indication of the potential performance should be given so that different arrays may be tentatively compared. Provided the readers realize that many factors such as antenna height and multipath reflectors can markedly affect antenna performance, no serious disputes should arise.

The theoretical gain of the 32-element sly beam is close to 21 dB when compared with a dipole. Many weeks have been spent in attempting to verify this gain figure experimentally but a reliable and accurate figure has not been obtained. On-the-air comparative tests using a dipole and a 5-element yagi generally support the theoretical gain figure. The antennas used for comparisons were carefully checked for impedance matching and resonante frequency. Measurements were made with the aid of a reliable stepped alternator fitted between the converter and tunable i-f system. Tests were conducted from two sites under a variety of conditions with stations up to 180 miles distant. The improvement obtained with the sly beam over the 5-element yagi on receiving tests was typically 2 5-units, or 12 dB.

On the long path between Dunedin and Wellington (370 miles) the sly beam has shown its superiority. On December 14 when Bill (ZL2CD) was in contact with Peter (ZL4LV) and ZL4TAH (me), Bill's signals were barely perceptible on a 5-element yagi at my Pigeon Flat DX site. On the 32-element yagi Bill's signals were easily readable.

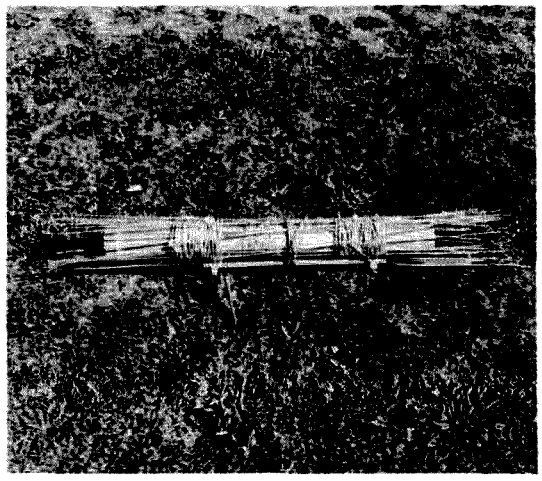


Fig. 4. A "sly" beam can be rolled on to a cardboard tube for transport.

Portable

Because the sly beam has no rigid boom, it can readily be rolled into a cardboard tube for transport to field day or DX sites. The total packed weight of the 32-element beam, excluding feedline, is about 2½ lb.

Usefulness

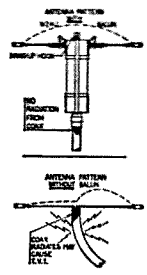
Obviously the sly beam is not intended for across-town contacts. With a simple antenna, such as a 5-element yagi, it should be possible to consistently work stations out to 100 miles or more, given average conditions and moderate transmitter power. If you cannot do this, fix your gear first or find yourself a good portable operating site, then think about building a sly beam.

For most DX purposes the fact that the array is fixed in direction may be of little importance. The 32-element beam described here has a beamwidth in the "E"



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plane of about 10° (at the half-power points). Thus at 200 miles the width of the main lobe is about 34 miles. My long yagi at Pigeon Flat near Dunedin has been carefully aligned so that the centerline of the main lobe passes close to Wanganui in the North Island. In the region of Wellington the main lobe (when it gets that far) would be 75 miles wide. Thus Christchurch, Wellington, and Auckland all lie close to the 10° solid angle enclosing the main lobe of the antenna on its present heading. In addition to the dispersion of a signal with distance, resulting from the diverging antenna beam, there is scatter due to topography and atmosphere. All this means that beyond 200 miles the area over which the transmitted signal will be heard and from which signals will be received is quite broad.

Future Development

Although the suspension system appears best suited to the yagi, it could readily be adapted for collinear or other types of array. Even with the yagi there is much scope for experimentation and development. An accurate measure of the gain of the sly beam and an assessment of the broadening of the bandwidth achieved by altering the tension of the suspension cords would be worthwhile projects.

A quick glance at Table I, which gives the length and spacing of elements, shows that apart from the reflector, the driven element, and the first four directors, the element length and spacing is constant. If a reflector, driven element, and set of launching directors were fitted to each end of the array, a switchable bidirectional antenna might result. This could prove handy for ZL2s who could then beam north or south simply by feeding the array at one end or the other.

Conclusion

The sly beam is an exceptionally high performance antenna which can be constructed in a single afternoon from all new materials for less than $10 (excluding feeder and masts). No special tools or fabrication techniques are required and anyone who can tie a knot could construct one. Unusual features of the suspended beam are its ability to be tuned by varying the tension on the supporting cords, its high gain resulting from its length, and its portable nature. It is best suited to fixed-direction communication beyond 100 miles and should make possible some rare DX communication on 2 meters and perhaps even a record-breaking contact between a first and fourth district station.

. . . ZL4TAH ■

THREE UNRELATED ARTICLES, EACH WITH A NEW IDEA FOR GETTING MORE SERVICE AND PLEASURE FROM YOUR RIG.

1 Installing the Swan 250-C Noise Silencer

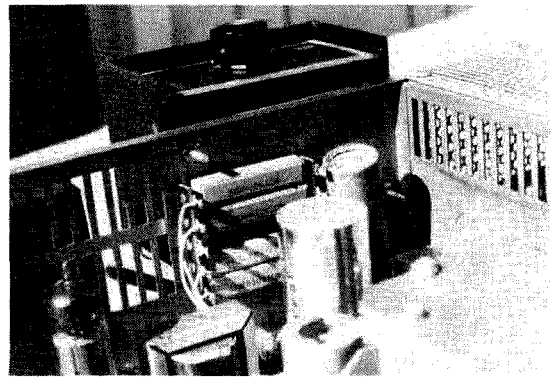
2 Measuring RF Output

3 Useful Cable Clamps

by Paul Schuett WA6CPP
14472 Davis Road
Lodi CA 95240

Installing the Swan 250-C Noise Silencer

Installing the noise silencer in the Swan 250-C can be a problem if it is done according to the factory directions. Their way requires the noise silencer to be disassembled every time the transceiver's top is removed. They're probably hoping that the purchaser will never have to open the top – except every couple of years or so to change a tube – however, this is not necessarily the case.

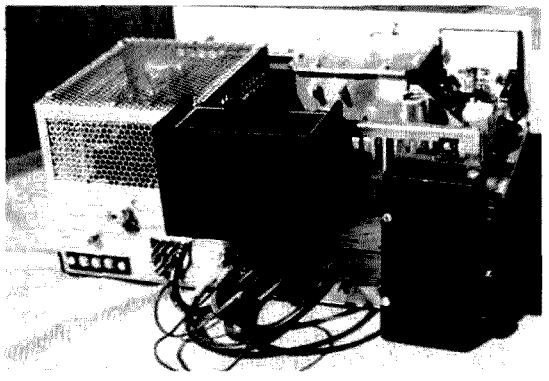


Inside view of 250-C showing the two bolts to mount the noise silencer (the other one is just right of the electrolytic).

I installed the silencer on the back of the unit. There was already one hole drilled there; careful planning will enable you to place another hole at a critical spot for two-point mounting.

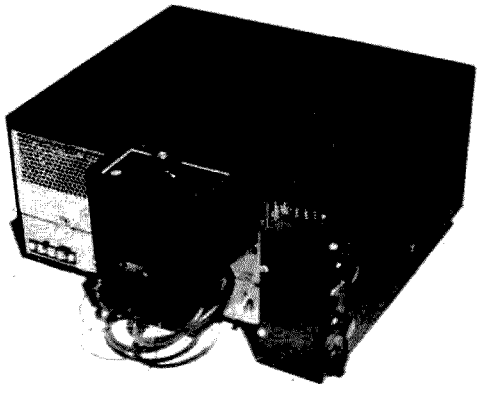
Be careful not to mount the silencer snugly against the transceiver or the top won't fit on. An extra nut on each screw will act as a spacer providing the necessary clearance.

There is all sorts of wire left over which could probably be cut off. I just wound it up in a circle so as not to be bothered soldering connectors. Be sure to remove the jumper wire inside the transceiver between the IN and OUT jacks.



Back of unit after mounting silencer.

This silencer works quite well on silencing ignition-type interference that seems to be the curse of all 6 meter operation, but is ineffective against the "solar noise" that comes and goes.



Back of unit after completing work. Wires probably could be shortened.

This silencer is also sensitive to any stray rf that the antenna picks up. There are three other 6 meter men within six miles of my home – this device will detect the rf and send it to the speaker whenever they operate, even if (especially if) I'm not tuned to the same frequency. The other day a police car drove by with the radio in operation, somewhere between 40 and 50 MHz, and it picked that up. The Swan factory advised me there was no way to eliminate that problem – inherent in the FETs.

Installing the noise silencer on the back of the unit makes it convenient to remove the top for service, does not distract from the appearance of the equipment; and it is no great problem to reach back there to turn on and off if you remember to keep the knob up.



Front view of completed project. Be sure to line top of silencer with top of transceiver.

Measuring RF Output

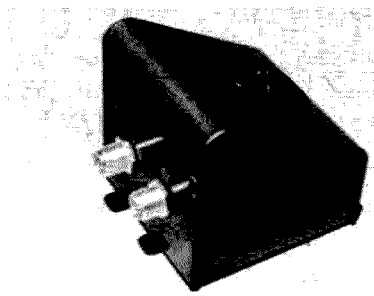
So your new Bandjammer 5000-Q is rated at 752W peak power. Big deal. How much of this is getting out where it counts?

It's easy to find out by inserting an rf ammeter in series with the line. A more exact reading would be to have the rf ammeter at the antenna input terminals, but that might be impractical when it comes to reading the meter (although you could put a diode there and a remote-reading meter in the shack).

Recently I found an rf ammeter at one of the mail-order surplus houses for $2.95. I installed this in a little cabinet, put two coax connectors on the back (in and out) and now can read rf current in the line, into the dummy antenna, or wherever it is going.



Inside wiring is extremely simple. Note ground wire installed to insure continuity of the shield circuit.



The completed instrument showing the coax connectors on the rear.

Remember the formula $P=I^2R$? Square the reading on the meter, multiply by the impedance of the line you're using, and you have the power past that point. At the antenna, you could determine the antenna resistance and take the current reading at that point.

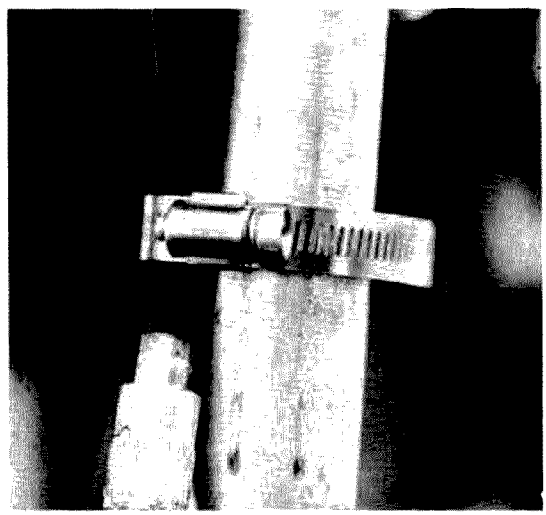
When tuning up the rig, place the ammeter on the antenna side of any tuning or matching devices and tune for maximum current.

It's amazing to learn how much (or how little) current these rigs produce. For instance, my Swan 250-C puts 1.35A into a 50Ω line. My friend's SB101 from Heathkit put out 0.7A until we worked on the antenna – then it put out about 1.25A. My Heathkit SB401 puts anywhere from 2 to 0.6A into a 50Ω Cantenna, depending on what band it's on.

Commercial stations determine their power by the antenna current. Knowing the antenna resistance at the operating frequency, they multiply that by the current squared. If the antenna resistance is 62½Ω, 4A rf would be 1 kW into the antenna. 126.48A would be 1 MW.

Remember the ammeter does insert a little reactance in the line (I never leave it in all the time), and the calibration changes with frequency, although you can tell what side of the ballpark you are on. An rf ammeter in the shack makes a nice piece of test equipment.

Useful Cable Clamps



Radiator hose clamp used for coax-to-mast application at WA6CPP.

After using plastic tape to hold coax to mast, and after having a big mess trying to undo the tape, I came up with the idea of using automotive radiator hose clamps to hold the coax to the mast.

These clamps are available at almost any automotive supply outlet or discount store, come in a number of sizes, and are relatively inexpensive.

Several coax lines can be held with one clamp.

The worm gear does not loosen in time and holds the coax securely. Be careful not to tighten down too far, however, as it could cause a problem in the future. Just "ease down" until the cable is snug.

WA6CPP ■

1/4 TOP-LOADED MOBILE ANTENNA

. . .an efficient short 1/4 wave twenty meter dipole

Henry W. Strege W5AZE

Increasing the efficiency of a mobile antenna has always been a worthwhile project to me, especially so, after reading the first paragraph of the article, *The W8 High-RF Short Beam,* by David L. Walsh W8HRF, in the Feb. 1969 QST. This paragraph shows how a short dipole can be made more efficient by end-loading with a coil and capacitive hat: The radiation resistance is increased while the coil losses are decreased. An illustration on page 496 of the 1969 ARRL Radio Amateur's Handbook shows why more power is radiated with this type of antenna. Note the ground-loss resistance is given as 10Ω or more in the above reference. The W8HRF article applies to a ½λ dipole. I decided to try this idea with a ¼λ 20 meter mobile antenna, which is 7 ft 4 in. (including the antenna mount on the car).

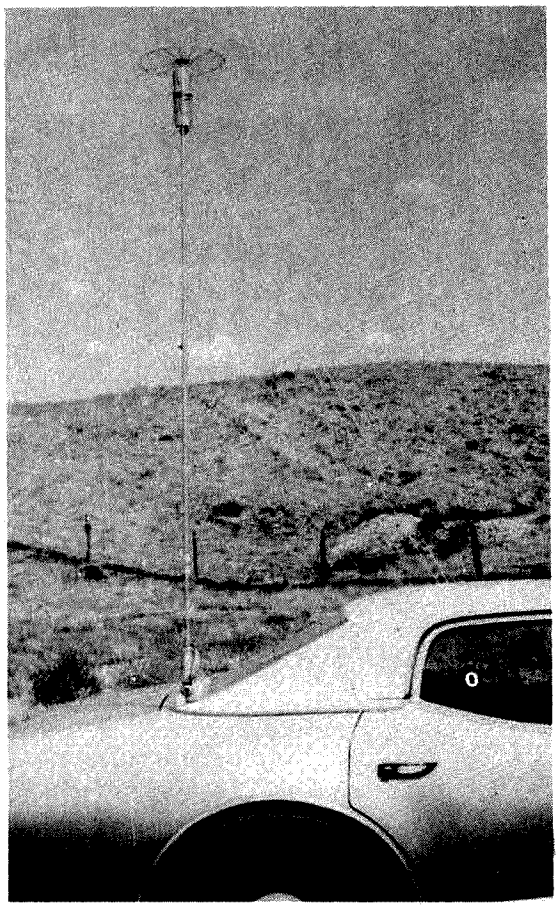
Comparison

My commercial antenna has a continuously variable coil, adjustable from 3.8 MHz to 29.0 MHz. Both antennas were adjusted for resonance at 14.235 MHz. Reports from different parts of the country, including one from the Hawaiian islands, indicated that the top-loaded antenna is one S-unit better than my commercial antenna. This difference was obtained by checking each mobile antenna with the trap vertical on the house, switching quickly from one to the other, to avoid fading effects. The two mobile antennas were interchanged on the car near the house, fed through 75 ft of coax cable from the base station. The commercial antenna was down two S-units while the top-loaded antenna was down only one S-unit from that of the house antenna. The transmitter PA current changed only 7% when switching antennas, which would not significantly affect the results. This 6 dB gain should be equivalent to increasing the transmitter output by a factor of about 4. This is a cheap and easy way to increase power output as well as receiving ability.

The top-loaded antenna is a little top-heavy and needs guy cords or light ropes to keep it from leaning back or swaying out from the car. I used two nylon cords, anchored at the coat hooks above each rear window, passing through the top of each window to the bottom of the coil. At speeds of over 60 mph a low howl can be heard; however, a person usually slows down when using the mobile rig.

Input Impedance

To find out how much the radiation resistance was increased, an rf bridge was



constructed similar to the one described in the article, *How to Hang d Dipole*, by James Ashe W2DXH, in 73, May 1968. The input impedance of the commercial antenna was measured as 30Ω and that of the top-loaded was 42Ω; both antennas resonated at 14.3 MHz. This would indicate a 12Ω increase in radiation resistance, as the ground-loss resistance would not change appreciably for the two measurements. The coax feedline was disconnected from the antenna, and the rf bridge connections were made as short as possible – in my case, 3 in.

Construction

The construction of this antenna is similar to that used in the W8HRF article except I used only half the driven element. I used a 12 in. capacitive hat from a previous project, with 16 spokes made of 12-gage hard-drawn enameled wire. With the total length of the ¼λ dipole, the required coil was made with 25 turns of 9-gage aluminum clothesline wire (2½ in. outside diameter and 8 in. long). I made this dipole in two sections so that it could be dismantled and carried in the trunk of the car. I used ½ in. aluminum tubing for the bottom half and a slightly smaller tubing that would slide inside for the top half.

One of the two sections was made 3 in. longer to allow for telescoping. For the insulating section I used a 5/8 in. wood dowel trimmed at the ends so it would make a tight fit 1 in. into the top half of the dipole and into a 1 in. piece of ½ in. long tubing. Two opposing sections were cut off and the other two sections were bent in at right angles, one over the other. In the center of this bent-over section, a hole was drilled and tapped for a 10-32 bolt. A 1 in. long bolt was inserted and threaded through from the open end of the tubing before being fitted over the wood dowel.

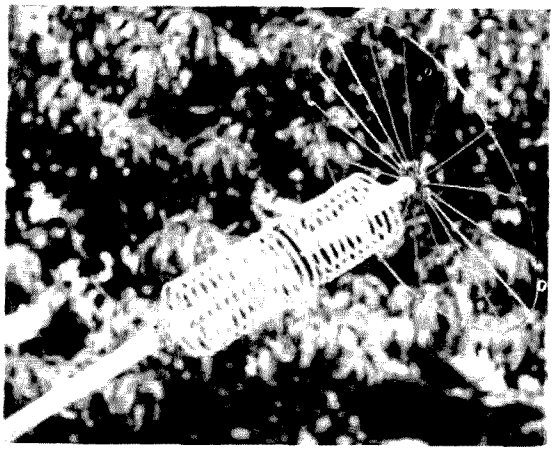
It is advisable to secure the dowel inserts in the tubing with small bolts or screws.

Before mounting the coil the wooden insulating section should be given one or two coats of shellac and after thoroughly drying, one coat of marine spar varnish should be applied. This should keep the moisture out for a long time. One end of the coil was formed into a small loop to take the 10-32 bolt; the other end was straightened out to lie parallel to the aluminum tubing.

The loop end of the coil and the capacitive hat were put on the 10-32 bolt at the end of the insulating section and fastened with lockwasher and nut. The insulating section should be centered in the coil. The other end of the coil was fastened to the aluminum tubing with a small stainless steel automotive hose clamp, available at most car repair or filling stations.

Four equally spaced slits, about 2 in. long, were cut at one end of the bottom tubing section, the one with the largest diameter. The two sections of tubing were then telescoped together for about 3 in. and clamped with another stainless steel hose clamp. The junction was marked so that it can be assembled again to the same length.

This type of construction allows the antenna to be taken apart and carried in



the trunk of the car when not in use. The bottom of the antenna was fitted with a bolt which would fasten onto the antenna mount on the car. The center of the coil should be supported as suggested in the W8HRF article. I used two small Bakelite strips fastened with small wood screws to the center insulating section. I tied the coil wire to the Bakelite strips with fishing line through small holes drilled near the ends of the strips and covered them with coil dope.

Adjustment

With the antenna fastened to the antenna mount on the car and the feedline disconnected, a small half-turn link was connected between the bottom of the antenna and one of the mounting bolts on the car body. A grid-dip meter was used to check antenna resonance. The coil was adjusted by moving the hose clamp, at the bottom of the coil to spread or compress the coil until the grid-dip meter showed resonance at the chosen frequency With the meter left in the dip position, the frequency should be checked on the station receiver for a more accurate reading.

I found a small change in the position of the hose clamp gave a large frequency change. I bent the end turns a little for the fine adjustment after making the coarse adjustment with the hose clamp. Other adjustment procedures using an swr bridge or a field strength meter can be used to tune the antenna to resonance. The swr reading changed very little when the frequency was changed from 14.2 to 14.3 MHz.

. . . W5AZE ■

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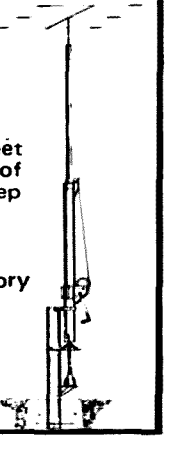
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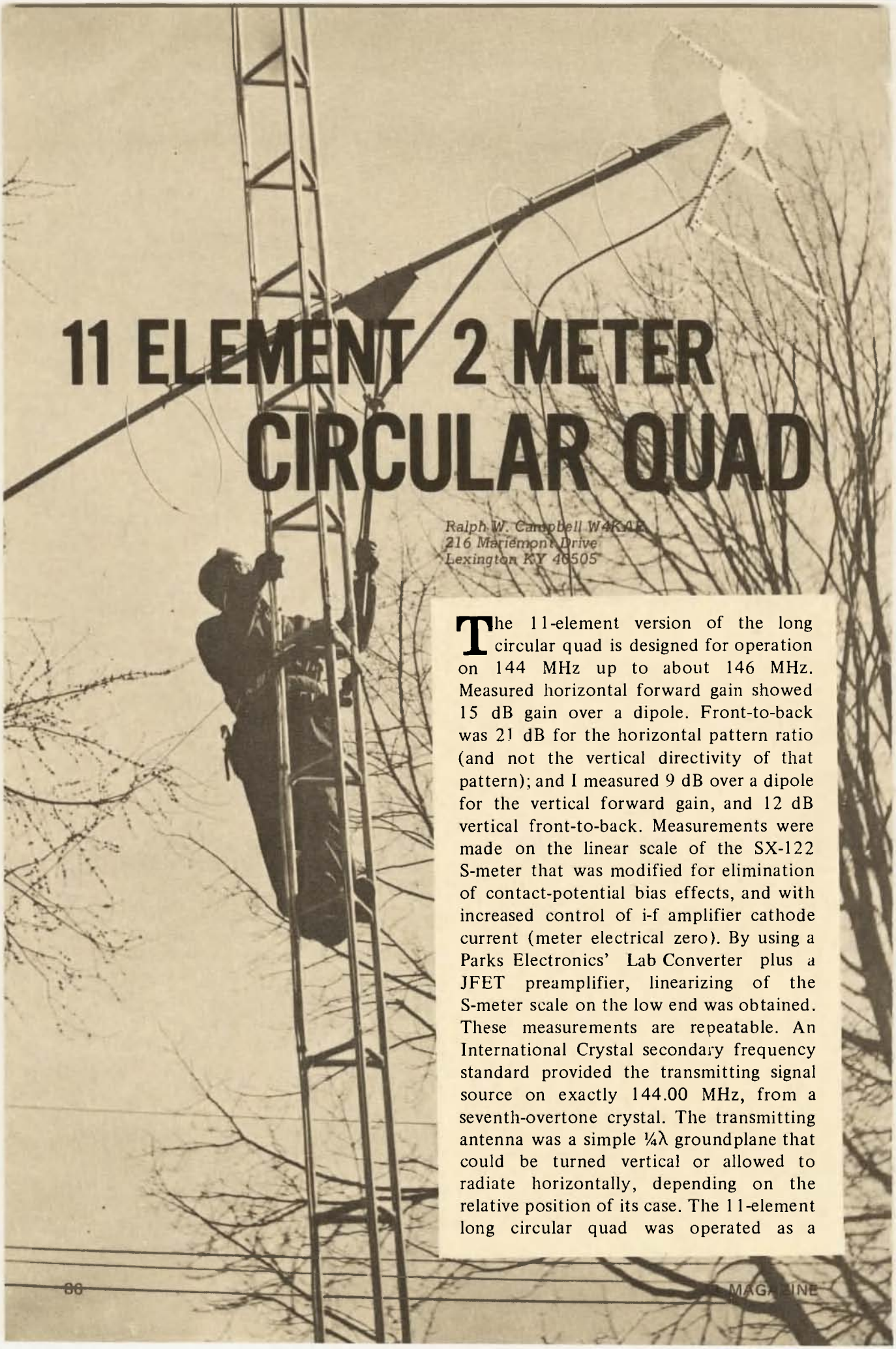
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11 ELEMENT 2 METER CIRCULAR QUAD

Ralph W. Campbell W4KAE
216 Mariemont Drive
Lexington KY 40505

The 11-element version of the long circular quad is designed for operation on 144 MHz up to about 146 MHz. Measured horizontal forward gain showed 15 dB gain over a dipole. Front-to-back was 21 dB for the horizontal pattern ratio (and not the vertical directivity of that pattern); and I measured 9 dB over a dipole for the vertical forward gain, and 12 dB vertical front-to-back. Measurements were made on the linear scale of the SX-122 S-meter that was modified for elimination of contact-potential bias effects, and with increased control of i-f amplifier cathode current (meter electrical zero). By using a Parks Electronics' Lab Converter plus a JFET preamplifier, linearizing of the S-meter scale on the low end was obtained. These measurements are repeatable. An International Crystal secondary frequency standard provided the transmitting signal source on exactly 144.00 MHz, from a seventh-overtone crystal. The transmitting antenna was a simple ¼λ groundplane that could be turned vertical or allowed to radiate horizontally, depending on the relative position of its case. The 11-element long circular quad was operated as a

receiving array for these tests. Antenna height was 70 ft above flat ground, thereby eliminating ground reflections.

Theory of the 11-Element Circular Quad

Initial measurements – made by an organization having ties with Project Oscar – showed 18 dB gain over isotropic (not over a dipole), since the pattern was obtained while my antenna was *transmitting* on 1000 MHz to a reference antenna receiving the signal. I am very grateful to those who made the tests possible; however, there is one point that should be cleared up: There is vertical polarization in the major lobe, which means some circular is generated. Repeatable tests have shown – on this 2 meter model – that with 11 circular group-phased elements there's 9 dB/dipole forward gain on 2 meters; and 12 dB/dipole front-to-back for the vertical pattern! According to WØHTH, some circular polarization is always present in most common antennas. If you try to test your own antenna, remember that the structure under test cannot be operated in the transmit mode for reliable readings. Grouping the elements as shown in the photographs boosted horizontal receiving-mode gain by as much as 5 "real" dB on the 18-element structure. At present, the gain of an 11-element circular quad is 15 dB/dipole, with an estimation of 18 dB/dipole possible with 18 properly phased (*not* like a yagi) elements.

Screen size is also a factor in reconciling gain expected with actual measurements. As you increase forward gain, front-to-back tends to decrease, with any major improvement in the forward lobe. This doesn't hold for yagi arrays, for example, since adding extra elements to make it "long" reduces the overall efficiency to such an extent that a slight increase in forward gain is the only effect. And, by adding even more elements, considerable power is dissipated as element "heat" if we could measure it! This is where I stopped further research and developed "driven" parasitic director groups. Getting back to screen size, you can expect an increase of 2 dB by increasing screen size from 4 to 8 ft



Fig. 1. This photo shows the completed 11-element 2 meter circular quad. Screen size is only 4 ft, and found to be inadequate, unless it could be increased to 200 inches. An 8 ft diameter screen reflector would have cost $48 for materials alone! Forget about "chicken wire" and you'd need a "cherry picker" for hardware cloth, because of the weight.

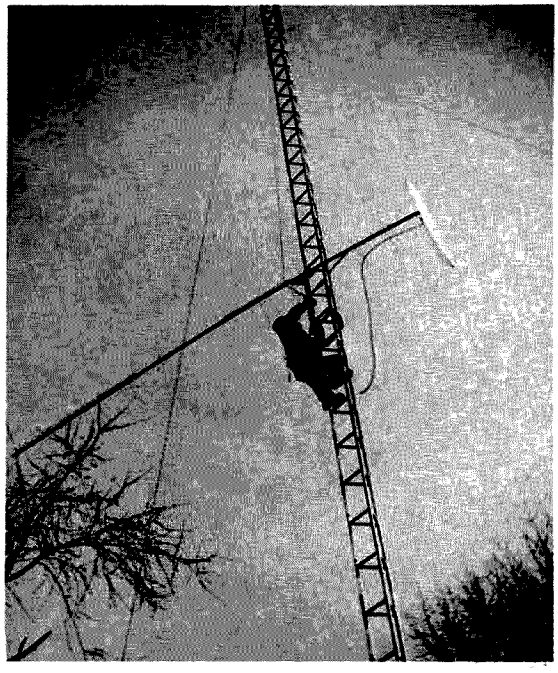


Fig. 2. Carl Day made 2½ round trips before final ground readings were taken as being acceptable.

diameter; however, I would expect front-to-back ratio to increase to only 24 dB. Hopefully, the horizontal forward gain would be 17 dB/dipole!

Construction

Figure 1 shows the completed 11-element 2 meter quad. The boom is made of thin-wall aluminum TV mast and is quite strong. The screen is a braced, two-part structure covered with half-inch Macklanburg-Duncan "expanded aluminum" mesh (chicken wire won't do!). The top set of guys is attached at the 60 ft level.

Figure 2 shows the antenna man's position at the 40 ft level; and the tower is back-lighted nicely against a darkened sky. This photo shows most clearly the connecting tower bolts and the aluminum *Foamflex* transmission line taped to it. Note especially the slipknot of rope around the first director in the first (common) group. You can see the element wiring if you look closely



Fig. 3. Seen here is one of those crucial moments when "you don't know if he can make it but you don't dare ask!" Since this was a success with a 4 ft screen, a later modification to include a driven, reverse-phased aluminum element certainly made the job easier.

Figure 3 shows perhaps the most hazardous or in-between position of the tower and 11-element quad. He made it! (But I had some doubts because of guy wire breakage the day before.) The top of the gin pole is at 80 ft. I was on the ground pulling up on the line streaking down to the left. This shot is included in the article to show how a steeplejack or tower construction man can safely erect this antenna. Incidentally, boom length is 21 ft and screen diameter is 4 ft.

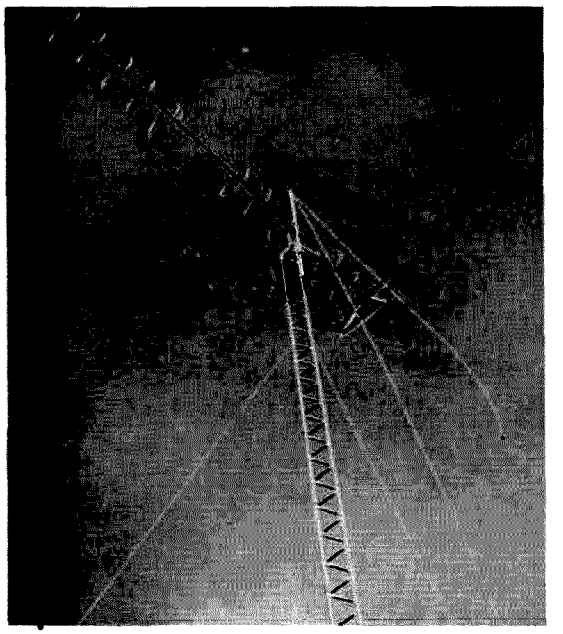


Fig. 4. The array is in position, with ropes gleaming in the sunlight. Use of a rugged gin pole is an essential.

Figure 4 is a dramatic one. With erection lines streaming in the wind Carl Day is tightening down the mast bolts prior to connecting the RG-8/U to the aluminum *Foamflex*. We used a Dill Tower TV tower for a rugged $10-per-section mast. Rohn 1¼ in. heavy galvanized mast is used to rotate and support the 11-element quad.

Figure 5, a closeup of the driven-element connections, reveals the screen-mesh structure. The round 9 in. flat plate is connected to the aluminum A-frame struts. The plate is made from M-D yellow brass. Plate-to-boom attachment is accomplished using right-angle shelf brackets which are thoroughly bolted to the boom with 3/16 galvanized roundhead machine screws. Rivets are used to hold the screen to the A-frame. From this position we can also see where the boom was electrically broken

with an external nylon sleeve; this was to prevent irregularities in the antenna's pattern; however, it was not found to be completely necessary. Figure 5 also shows a *Cushcraft CL-116* collinear element block. These circular elements were bent in a local sheet-metal shop. Sufficient care must be used to prevent breaking the mounting block (especially when straightening an already mounted loop). Connections to the block are made with 200Ω *Federal Wire and Cable* transmitting twinlead. The other end of the twinlead goes to a *Sound & TV Systems* 4-to-1 ferrite-core VHF balun. The balun is wound on an IRN-9 core, available from *Permacor* Division of Radio Cores. I used 14-gage wire for the windings, insulated with shrinktubing on the inside. The wound core is next encapsulated with GE silicone rubber. The encapsulated balun is then housed in a large rubber *Muellar* boot and taped thoroughly. The vswr is unity at 144 MHz; it rises to about 1.5 to 1.0 at 146 MHz. The *Cushcraft* collinear elements need to be shortened 2 in. off each *reflector* half-loop plus an additional length for the distance from block terminal to block terminal. An inch off each Cushcraft *driven element* is all that is required for the 38 in. elements.

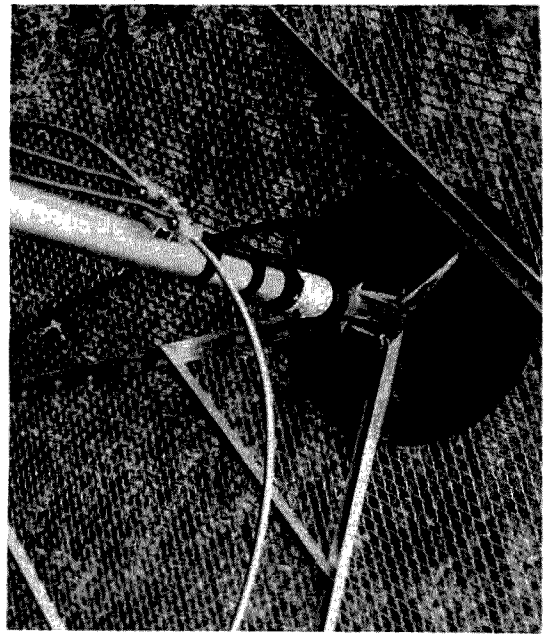


Fig. 5. In a later version of the same 11-element 2 meter circular quad, the screen reflector was cut off the hind portion of the boom, and an extension of the boom was made to allow the new reflector to have proper 19 in. spacing from the first driven element.

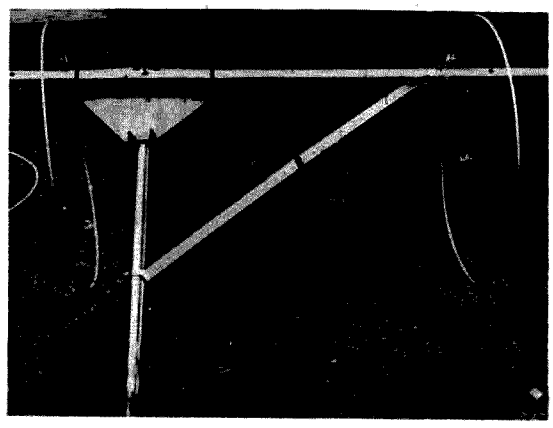


Fig. 6. Detail of the insulated strut from mast to boom. Notice the element ends. Mounting and physical connections with these elements are critical! (Loc-Tite nut and stud lock is mandatory for holding screws in place, unless you have stainless-steel lockwashers.)

Figure 6 shows closeup of the elements, brass gusset plate, and the electrically broken boom-to-mast brace. The gusset plate is patterned after another design except that it is made of brass and not ¼ aluminum. Another improvement is that there's a bolt all the way through both the masting and the boom! Muffler clamps are also used, instead of the usual clamp. Since our mast is smaller than the boom, a piece of scrap rubber garden hose serves to bind these surfaces. The broken boom brace is a piece of scrap aluminum 1/16 in. angle, riveted to a solid PVC block.

Each end of the Cushcraft circularly bent elements is butted against each other inside a steel ¼ in. shaft coupling previously drilled through with a 1/8 in. bit. After drilling, element half-loops are inserted about midway, drilled in place, and riveted. This is the only way I could find to rigidly connect elements without breakage.

The driven elements are 76 in. diameter, with allowance made for block-to-block spacing. The first group of directors are all

cut to have an overall circumference of 72 in. The second group of directors all have an overall circumference of 68 in. For a given constant in inches we can arrive at a formula which we divide by frequency in MHz to get the correct lengths. (Slide rule accuracy is all that's necessary.)

Driven Elements	1st Directors	2nd Directors
$\frac{11,050}{F_{MHz}}$ = ans. (in.)	$\frac{10,375}{F_{MHz}}$ = (in.)	$\frac{9,800}{F_{MHz}}$ = (in.)

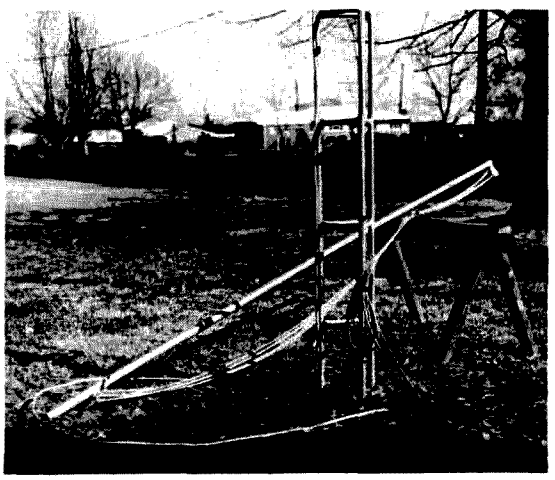


Fig. 7. The aluminum Foamflex transmission line (shown here above-ground) has been buried in a shallow trough; now I have a good crop of Kentucky bluegrass over it.

Figure 7 shows erection equipment, rope line for the gin pole, and a closeup of the bottom section as it attaches to the Dill Tower "Pickle" base. I like to call it the "mud base" because all you do is dig a 4 ft hole in decent soil, then slide the base into it and refill with mud; all the while mixing in water from a garden hose. Let the mixture set for several hours and periodically check the vertical angle with a carpenter's level. If you let the mixture become completely hardened, it is possible to erect up to 4 tower sections, without guys! Always guy at least the 20 ft section before going further. Another advantage of the Pickle base is that it may be left in the earth, should you decide to move, and the other tower sections can be saved for a new site.

Amateur Use

Successful use of the 11-element circular quad dates from the first evening it was compared with my 28 ft L-matched yagi. Both the quad (boom length just over 20 ft) and yagi had the same forward gain. However, the yagi canceled out vertical 2 meter signals just as effectively as if the coaxial cable was disconnected from the receiver! Not so for the round quad. (I will be glad to demonstrate this test to any 2 meter mobileers.)

Here in Lexington, Ky., we have had no recent stratobending band opening to fully evaluate the array's performance with DX. However, it receives the usual 75 mile groundwave signals better than the 28 ft yagi. Scatter pickup is at least 3 dB better (by the ear). Curiously enough, "coaxial cable noise" was first noticed with yagi in comparison to the circular quad. After repeated checks as to carrier strength at 75 miles, with antennas at the same height, it was obvious to reporting stations that the horizontal forward gain was equal. The important difference between arrays is that my RG-9/U silver-plated coax was much noisier than twice as much aluminum *Foamflex* cable, fed to the equal forward-gain antennas! Receiving signal strengths favored the quad. Perhaps the most overlooked point in antenna design is reduction of fading. With a circularly polarized antenna fading is less – but never eliminated without a complicated VHF diversity feed. But the 11-element round quad is a step in the right direction.

Conclusion

Although I do have a patent pending on the long circular quad, I feel that since it is a breakthrough in antenna design, it should be passed on to the amateur fraternity. The only yagi characteristics this array has is in shortening each group of parasitic directors. There are many new variations which I see possible, like group-phased half-wave parasitic elements, a driven reflector within the first group, and "squaring" the round elements to make a "top-vertex-fed" conventional quad. Top vertex feed on each full-wave element would probably eliminate the vertical pattern and boost the gain!

. . . W4KAE ■

E.R. Shepherd ZL2ASJ
105 Mayfair Ave.
Hastings, New Zealand

THE "663" BEAM

...for 10, 15, and 20 meters

The varying degrees of success I have attained with beams using loaded elements, trapped elements, compromised matching networks, and tuned lines led me to a project which resulted in the design and construction of a beam - an efficient three-band beam for 10, 15 and 20 meters.

One of the primary design goals was a beam that would give performance comparable to three individual yagis: the result was a 3-element antenna on 20m and a switched 6-element collinear array on 15 and 10m. Full 6-element beams show higher gain figures, of course.

Necessary prerequisites were:-

- A single coax feedline with low SWR
- All elements in use on all bands
- No high-Q traps or stubs
- Manual band-switching by remote control
- Must be full size on the lowest band

The completed beam is no bigger than a full size 20m 3-element yagi on a slightly shortened boom (this is the only compromise and does not affect the bandwidth on 20m). Viewed from ground level it appears to be a mono-bander. The "663" title is derived from 6 elements on 10, 6 elements on 15, and 3 elements on 20m.

Mechanical

The mechanical construction is quite straight forward. Two lengths of wood forming the boom are 2 x 1½ in. x 16 ft long; the cross spars for mounting the elements are 1½ x 1½ in. x 9 ft long. Try to obtain straight-grained wood with no knotholes or splits, and apply many coats of the necessary weatherproofing agents. The woodwork is bolted together with ¼ in. galvanized coach bolts. As each of the elements is split in the center, 4 insulators are required on each spar. The insulators are those used for mounting bus bars in switchboards; they are attached to the spars with heavy brass wood screws.

All metal parts should be galvanized steel, brass, or aluminum; and remember that you can put galvanized steel with aluminum but NOT brass or copper, due to corrosion. The elements are Dura tubing, tapered in three steps commencing at 1 in. diameter and reducing to 7/8 in. and then to ¾ in. for the end tips.

Where the elements telescope together they are slotted and hose-clamped. Similar clamps are used for mounting the elements to the insulators.

The boom is braced with 4 struts back to the main support pipe or mast made from ¾ in. galvanized conduit 6 ft long. Top guying of the boom could be employed instead of the struts. The remainder of the mechanical construction is obvious from the photographs and it can all be assembled from readily available parts.

Mounting of the beam to the tower or mast is left to the builder. Mine is a two-point mount thus enabling the boom to be tilted over one way or the other for adjustment or maintenance.

Electrical

The heart of the whole triband feature is the various switched networks inside the weatherproof boxes in the center of each element. These boxes are plastic containers with airtight lids as used for storing food in refrigerators and are available from most stores for about 60¢ each. Each box has a ¾ in. diameter vent in the bottom covered with plastic gauze.

All capacitors are isolated from ground by mounting straight to the plastic case for the radiator tuning unit or on strips of polystyrene for the parasitic elements as evidenced in the photographs. All the capacitors are adjusted at full height so an 8 ft length of 1 in. dowel is used as a long trimming tool to reach the capacitors on the director and reflector. The capacitor shafts have a flat filed on them to match an adapter on the end of the 8 ft dowel. On 20m the 3 large ZC1 type relays (RL1) are energized, thus sorting out the parallel networks in all elements, and in the case of the driven element, connects the coax feedline to series capacitor C3 on the 20m omega match. (Although this setup looks like the conventional gamma match, it is actually an omega match due to the stray capacity in the tuning box.)

The tuning of the beam on 20m is determined entirely by element length and these were taken straight from Bill Orr's Beam Handbook with slight reductions to allow for length of the ZC1 relays and connecting braids. The element lengths are as follows:

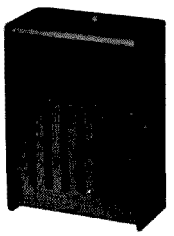
Director – 30 ft, 9 in.
Radiator – 32 ft, 10 in.
Reflector – 34 ft, 8 in.
Matching rod – 36 in., 3/8 in. diameter, spaced 5 in. center to center from radiator.

Series capacitor C3 is a 150 pF transmitting type. All elements have a gap of 4 in. at the center. Referring to the diagram, note that RL1 (b) contacts seem to be unnecessary, but utilizing the coil center-tap for the earth return to the coax gave odd reactive effects, so the coil was shorted out in all directions possible with the available relay contacts.

For operation on 10m, all the relays are left open, leaving a parallel-tuned circuit across the center of each element. The coax feedline is then tapped across one turn of the radiator coil by the changeover action of RL1 (a).

The position of the tapping point can be varied to suit the impedance of the coax and no series reactance capacitor was found necessary. The tapping point was found to be the same for 10 and 15m, one turn being the case for 50Ω heavy duty coax. Operation on 15m is achieved by

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energizing the three relays (RL12), connecting capacitors C2 across the existing 10m LC network.

The coils are wound with 3/16 in. diameter copper tubing, 2 in. internal diameter, spaced 3/16 in. between turns. The director coil is 7 turns, radiator coil 5 turns, and the reflector coil 8 turns. The radiator coil is smaller than the other two due to the longer connecting leads.

The parallel capacitors C1 and C2 (6 altogether) should have a capacitance of 30–40 pF.

The coils of the three ZO1 type relays (RL1) are wired in parallel requiring 12V dc at 600 mA. Likewise, the RL12 relays are parallel connected, requiring 24V at 300 mA. The two voltages are furnished by the one simple supply using a TV vertical output transformer and bridge rectifier. A 100 μF, 25V electrolytic capacitor is necessary across the output of the supply to eliminate relay chatter.

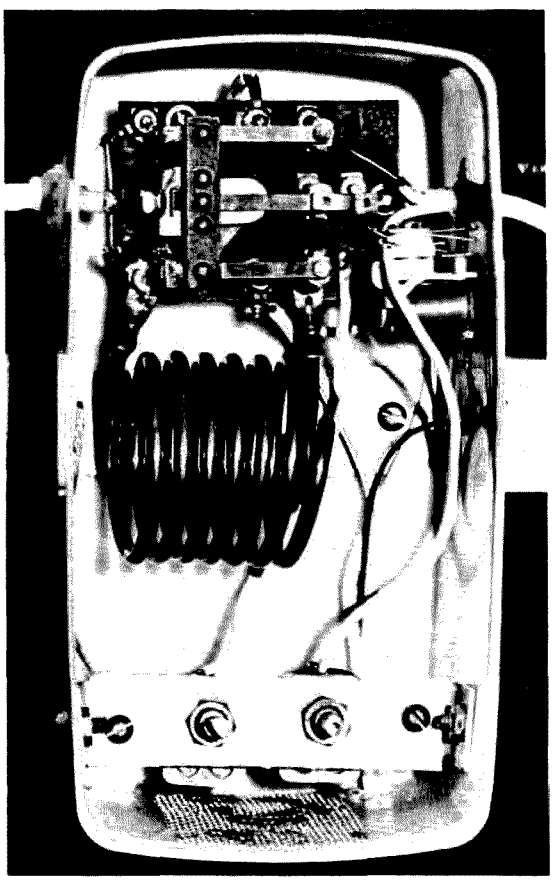
The relays used are war surplus items and can be replaced with more modern types. Five of the relays are spst. The RL1 relay in the radiator requires a 1-pole changeover and dpst contacts.

The switching sequence is as follows:

10m – all relays de-energized.
15m – RL2 relays only energized.
20m – RL1 relays only energized.

Tuning Up

The initial tuneup is at about 6 ft above ground just to ascertain that the various LC networks will cover the correct frequencies. The final tuning must be done as near as possible to full height – and takes up most of an afternoon! The setup was as follows: an swr bridge was in the feedline at all times; a remote dipole with the voltmeter extended back to the shack was used; a telephone from the shack to the top of the tower was most useful. All adjustments were done for maximum gain (front-to-back ratio was best at these settings) as measured on the dipole voltmeter; this naturally coincided with the lowest swr readings.

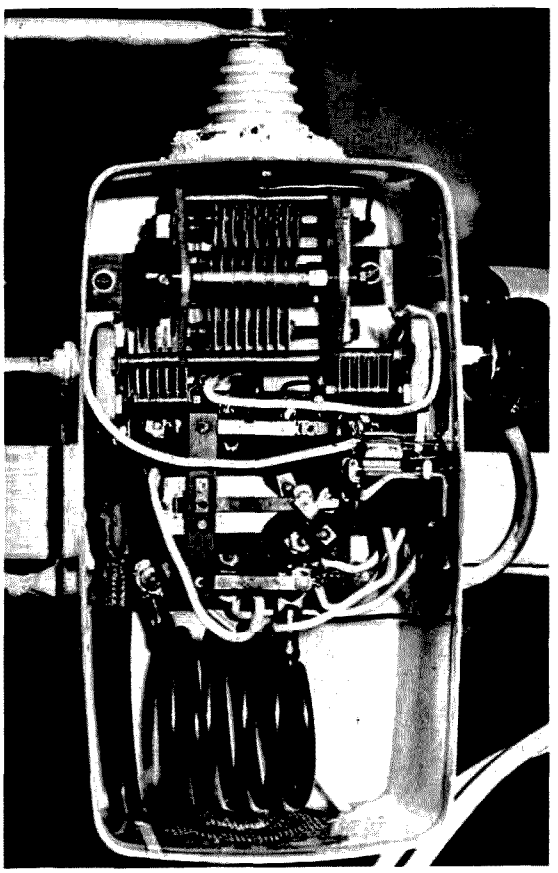


Director and reflector tuning unit.

Tuning is started at 20m by closing RL1 relays only. Check that the radiator is resonant on 14.2 MHz with a grid dipper, and if possible check the frequencies of the director and reflector to ascertain that they

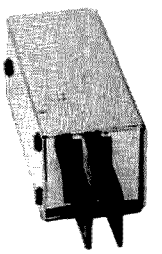
are just above and below the 20m band. An rf carrier on 14.2 MHz is applied to the beam, then the matching rod length and series capacitor C3 adjusted until the swr reading is nil. Front-to-back ratio can be checked and will be found to be about 25 dB. This completes the 20m tuning.

The next step is to deenergize all relays and apply an rf carrier on 28.6 MHz. Adjust the C1 capacitor starting with the radiator, then director, and then reflector for maximum gain on the dipole voltmeter. It pays to go over these adjustments at least twice to get best gain. Front-to-back ratio on this band is about 35 dB. Maximum gain will coincide with minimum swr, but if a complete null is not evident, move the radiator coil tap slightly one way or the other.



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Tuning on 15m is the last step and the RL2 relays only are energized with 21.175 MHz rf. Tuning on this band is the same as that on 10m except that the adjustment is made to the C2 capacitor.

The coil tapping point once set for 10m is correct for this band. Front-to-back ratio is about 30 dB.

Antenna Performance

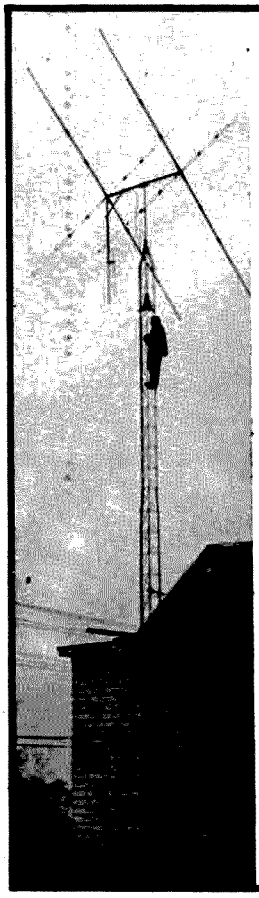
Conservative gain figures for the 3 bands are as follows:

20m – 8 dB
15m – 10 dB
10m – 11.5 dB

The swr will be unity at the resonant point on all bands and will rise up to no higher than 2:1 at the band edges on 20 and 15m. On 10m, an swr of no more than 2:1 was experienced at 28.2 MHz, dropping to unity and then rising to 2:1 at 29.1 MHz. This may appear to be a wide bandwidth for the swr stated, but I feel it attributed to the elements being a full wavelength on 10m.

This antenna has been in use here for 2½ years and the results obtained on all bands are most gratifying when compared to the automatic trapped beams and interlaced cubical quads.

. . . ZL2ASJ ■



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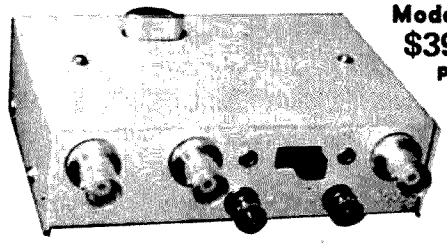
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	(1)	(2)	(3)	(4)	(5)	(6)
(7)	(8)	(9)	(10)	(11)	(12)	(13)
(14)	(15)	(16)	(17)	[18]	19	20
(21)	(22)	(23)	(24)	25	26	27
28	29	30				

EASTERN UNITED STATES TO:

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ALASKA	14	14	14	7A	7	7	7	14	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	21	21	21	21A	21
AUSTRALIA	21	21	14	14	7B	7B	7A	14	14	7B	14	14
CANAL ZONE	21	14	14	14	7	7	14	14	14	21	21	21
ENGLAND	14	14	7A	7A	7	14	14	14	14A	14A	14A	14
HAWAII	21	14	14	7A	7	7	7	14	14	14	14	14
INDIA	14	14	7A	7B	7B	7B	14	14	14	14	14	14
JAPAN	14	14	14	7A	7B	7B	7A	14	14	14	14	14
MEXICO	21	14	14	7	7	7	14	14	14	14	21	21
PHILIPPINES	14	14	14	7A	7B	7B	7B	14	14	14	14	14
PUERTO RICO	14	14	14	7	7	7	14	14	14	14	14	14A
SOUTH AFRICA	14	7B	7	14	14	14	21	21	21A	21	21	14
U. S. S. R.	14	14	7A	7A	7	14	14	14	14A	14A	14A	14
WEST COAST	14A	14A	14	14	7	7	7	14	14	14	14	14

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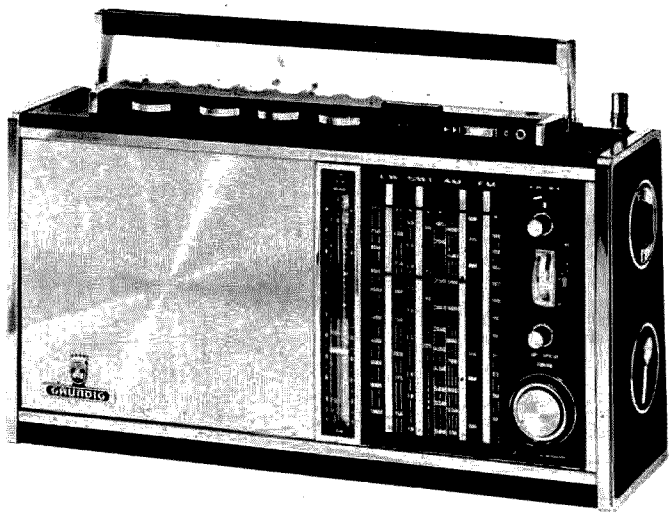
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CANAL ZONE	21	21	14	14	7A	7A	14	14	21	21	21	21
ENGLAND	14	7A	7A	7A	7	7	14	14	14	14	14	14
HAWAII	21	21	14	14	14	14	7	14	14	14	21	21
INDIA	14	14	14	7A	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	7B	7B	7	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	7B	7B	7B	14	14	14	14	14
PUERTO RICO	21	14	14	7	7	7	14	14	14	14	21	21
SOUTH AFRICA	14	7B	7	7B	7B	7B	14	14	14	14	14	14
U. S. S. R.	14	14	7A	7A	7	7B	7B	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	14	7	7	7	7A	7A	14	14	14
ARGENTINA	21A	21	14	14	14	7	14	14	21	21	21	21
AUSTRALIA	21	21A	21A	21	14	14	14	14	7A	7	14A	21
CANAL ZONE	21	21	14	14	7A	7A	7A	14	14	21	21	21
ENGLAND	14	7A	7A	7A	7	7	7	14	14	14	14	14
HAWAII	21A	21A	21	21	14	14	14	14	14	14A	21	21
INDIA	14	14	14	14	7A	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	14	7A	7	14	14	14	14	14
MEXICO	21	14	14	7A	7	7	7	14	14	14	14	14A
PHILIPPINES	14	14	14	14	14	14	7B	14	14	14	14	14
PUERTO RICO	21	21	14	14	7	7	14	14	14	14	14A	21
SOUTH AFRICA	14	7B	7B	7B	7B	7B	7B	14	14	14	14	14
U. S. S. R.	14	14	14	14	7	7B	7B	14	14	14	14	14
EAST COAST	14A	14A	14	14	7	7	7	14	14	14	14	14

A — Next higher frequency may be useful.
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73 tests the Grundig **SATELLITE** *Ham Radio Receiver*



...and is impressed!

Those crafty Germans have come up with a remarkable portable receiver, one that seems to have just about everything imaginable. Here is a receiver with separate bandspread dials for each of the amateur radio bands, a receiver that has a product detector so you can copy sideband and CW! It even covers 160m, tuning from 1700–2000 kHz. The 80m bandspread dial covers 3500 to 3800 kHz, with the remainder of the band being adequately covered by the regular shortwave band which covers 1600 to 5000 kHz. The 40m band covers 6900 to 7350 kHz, including CHU, naturally. There is also a 49m band for SWLs, tuning from 5950 to 6250 kHz. The 20m band covers from 13.9 to 14.5 MHz. 15m covers 20.5 to 21.75 MHz. 10m is in two bands, one from 26.9 to 28.4 MHz, which includes the citizens band, and one from 28.3 to 29.8 MHz.

There is also a band for low-frequency listening from 150 to 450 kHz, plus the broadcast band and the FM 88–108 MHz band.

It has so many features that it is hard to list them all. The i-f response can be switched from broad to narrow, giving optimum response for FM music and crowded ham-band reception. The speaker is huge and has a remarkable richness of tone for a portable radio. The receiver operates on built-in batteries or ac, and has a meter to show the battery voltage. The sideband unit has a narrowband filter (to cut down noise pulses) as well as a manual avc function. There are separate tone controls, an S-meter, a 13-section antenna, provisions for using your car antenna, an outside FM antenna, and a shortwave or ham-band antenna. There are inputs and outputs for a tape unit or phonograph player and a plug for external loudspeakers.

When we removed the Grundig from the carton here at 73 to test it just about everyone on the staff blew their minds over it. Everyone had an immediate case of wants. There was a tussle between the rock fans to listen to FM and the hams to listen to 20 meters. The receiver is stable enough to allow excellent sideband reception and there are enough controls to give you good flexibility in tuning in signals. This certainly could be used for communications for it does a lot better job than some ham receivers that are not all that much lower in price. The major advantage of this receiver is that it is portable and that it covers just about anything you would normally want – AM, FM, SSB, or CW. With a little converter it would be excellent for tuning in FM repeaters!

How To Order An Antenna Tower

There are many kinds of towers on the market today. You may choose the kind that requires guying or the type that is self-supporting. You may select a foldover, a crankup, or the kind that hinge at the base and then either fold over or crank up. Then there are the rigid types that rise section by section after the base has been securely planted. Towers are made of steel or aluminum. They can be of telescopic masting or braced triangular or of square-framed design.

Confusing? You can say that again!

So how do you sort out the facts? How do you know what *you* want?

First you must know what you can legally or permissively put up. This depends upon either the landlord or the zoning restrictions in your town. Then there is the esthetic consideration meaning mainly your good wife, and, of course, your neighbors' opinions too. For you to put up a stark ugly structure on the front lawn on a street of fine homes, you had best at least be prepared for some tongue wagging, or worse, a letter from the neighborhood improvement association. But assuming that such considerations as to where this structure will be placed have been settled, then you must decide what the tower will be used for specifically!

The tower selected must reflect the maximum windload in a horizontal direction which is imposed by your antenna, or combination of antennas, assuming a velocity of 80 mph (which is the minimum recommended standard). Depending upon historical weather statistics for your area, you must be conservative in choosing a tower design—a skimpy choice usually results in a total loss within a year or two. Go ahead then in adding up windload. With the small TV or VHF beams, 2—5 sq. ft. of load should be expected. Larger VHF beams in small 10 meter arrays require 5—8 sq. ft; 2 element tri-band quads also fall in this category. Typical tri-band 3 element beams require 8—11 sq. ft. A typical small VHF antenna stacked on top of a 3 element tri-band beam requires a total of 11—14 sq. ft. Two small HF 10 or 15 meter 3 element beams would call for 14—18 sq. ft., while even a single large 20 meter array requires 18—22 sq. ft. Even the light 40 meter beam needs 26 sq. ft. By the way, the sq. ft. of windload times 20 equals the lateral pressure in pounds at 80 mph. At 90 mph you multiply by 25, at 100 mph you multiply by 30, at 115 mph—40, at 130 mph, factor is 50, and at 160 mph you will use a multiplier factor of 60. And when you do all these calculations be conservative. In still another direction, that of your future ham operations, allow for the fact that you may want to expand your activities and thus your antennas.

Bear in mind that the height of your antenna and the top of your tower must be at least 5—10 ft higher than the average foliage in your backyard, and preferably should be halfwave or higher for the lowest frequency that you are going to operate on. In general, quads will provide satisfactory operation in lower heights than yagis.

Secondly, your bankbook must be consulted. While it is true that a ham's station performance is more directly related to good antenna performance, it is also true that your first obligation must be to the family and their needs. Some idea of cost can be gleaned from the following:

- Minimum cost of steel in 10 ft sections with guys, rotor plate, masting, anchors, etc. will be about $2.50 per lineal ft of erected height.
- Minimum cost of aluminum – 8 ft sections with rotor plate and masting (no guys) will approximate $3.20 per lineal ft of erected height.
- The minimum cost of a crankup or foldover design in a guyed steel tower will be about $5 per lineal ft of erected height.
- Minimum cost of self-supporting crankup or foldover steel tower will be $8 on the same basis per ft.
- Minimum cpst for a hinged base, aluminum construction, crankup or foldover self-supporting type will be $9 per ft of erected height.

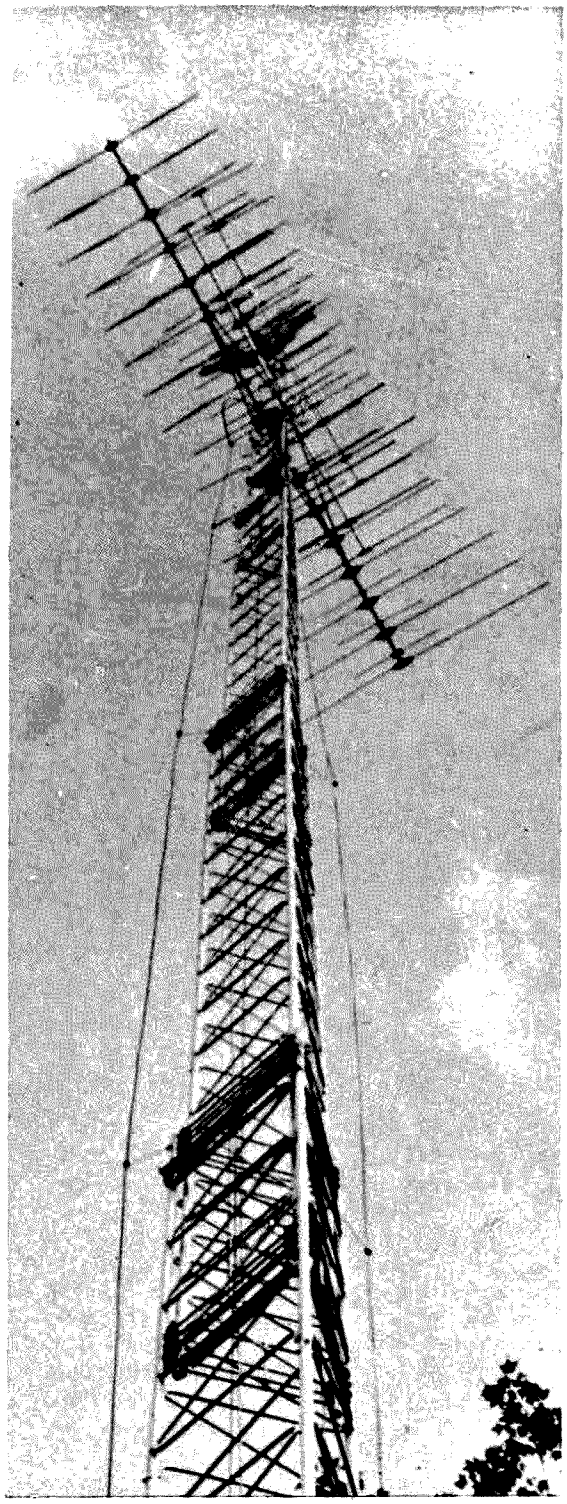
By referring to the above and knowing how high you wish your antennas to be, you can quickly compute minimum values for basic types of tower design. But please remember, these are minimum values, and our nation is in a depression/recession, with inflated or deflated prices, and we surely know prices go up, not down!

Remember, too, that there are other considerations. You wouldn't put a guyed tower in your backyard where your kids were playing ball. First thing you would hear would be a hysterical wife on the telephone. Then, too, how frequently are you apt to move? How easy is the tower to erect? Do you need two or three cases of suds and the whole club for a rooting section?

Maintainence is annoying, especially antenna repairs after a winter storm and you're 55 years old with four extra inches of spare tire to hinder your climbing. Another consideration is whether or not you have provided for the possibility that for some reason your tower and antenna may come crashing down on the neighbors home next door. Because of all these things and many others that you can think of to fit your individual circumstance, towers do take a lot of study

We sell them all, and literally have dozens in stock, but over many years of selling ham gear, we have reached the conclusion that one brand is especially appealing to the ham. I now refer to HEIGHTS Aluminum Towers, appealing because their design provides a great flexibility for your particular needs with respect to strength and height. Further, should your circumstances change, their design best lends itself to easy dismantling and reerection – to expansion – to freedom from the maintainence problems.

Detailed literature is available for the asking on any tower. Furthermore we'd be glad to quote on a package deal for any rotor, antenna, or tower combination or to render advice on your problem. We have helped others, maybe we can help you.



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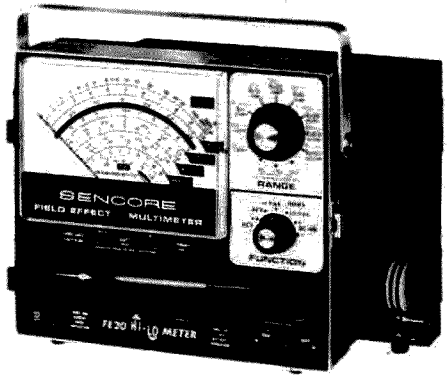
PHONE 617 456 3548



NEW PRODUCTS

In-Circuit Resistance Checker

The model FE20 "Hi-Lo multimeter checks conductivity of transistors, diodes, and rectifiers; with a flip of the function switch the ohms section is powered with a lower voltage (below the conductivity point of solid-state devices). Resistances can then be measured in-circuit for true values without solid state device conducting and causing erroneous results. Both Hi and Lo



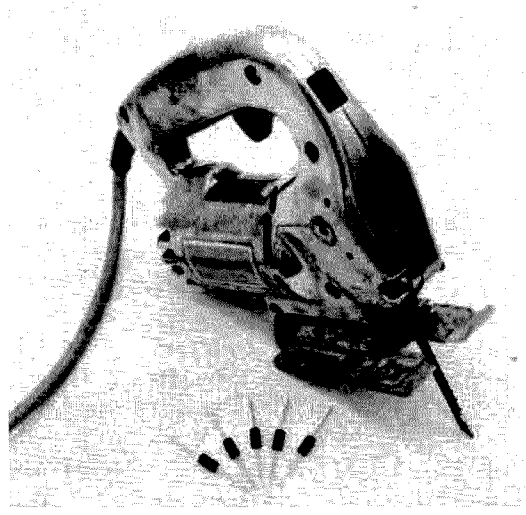
ohms are read on the same scale to avoid confusion. Other features include a tenth of a volt full scale for more accurate measurements of transistor biases. A high voltage probe is also shipped with each multimeter to extend the voltage range to 30,000 volts. A low voltage probe with isolation resistor is also provided. The new meter has 9 dc ranges, 3 high voltage ranges, 9 ac ranges, and 7 resistance ranges. The FE20 is priced at $129.50. *Sencore, Inc., Addison IL 60101.*

Semiconductor Data Book

The Motorola Semiconductor Data Book (Fourth Edition) is the largest yet – 2160 pages – and includes specifications for all discrete semiconductors registered by the EIA at publication time. The book also features a new arrangement of data that makes it easier than ever to find information on semiconductors; other sections of the book include case outlines for semiconductors, selector guides to digital and linear integrated circuits, and application notes that explain how to use the transistors, diodes, and other devices described in the Data Book. *Motorola Semiconductor Products Inc., Box 20912, Phoenix AZ 85036.*

3 Amp Epoxy Rectifiers

The ER2000–ER2006 series of plastic incapsulated, low cost, hi rel 3 amp rectifiers offers design engineers increased packaged density excellent hermeticity, low power dissipation and



high surge limit in high temperature applications. Voltage range is 50 to 1000V with mass surge limit of 200 amps. Average forward current is 3 amps. *Transitron Electronic Corp., 168 Albion St., Wakefield MA 01880.*

3 kW Vacuum Coaxial Relay

A vacuum coaxial crossover/transfer relay utilizing both a vacuum dielectric and the latest in coaxial switch technology is now available. The Series 313 will handle up to 3 kW of power at 30 MHz. It utilizes switch contacts enclosed in a vacuum dielectric in a copper and ceramic

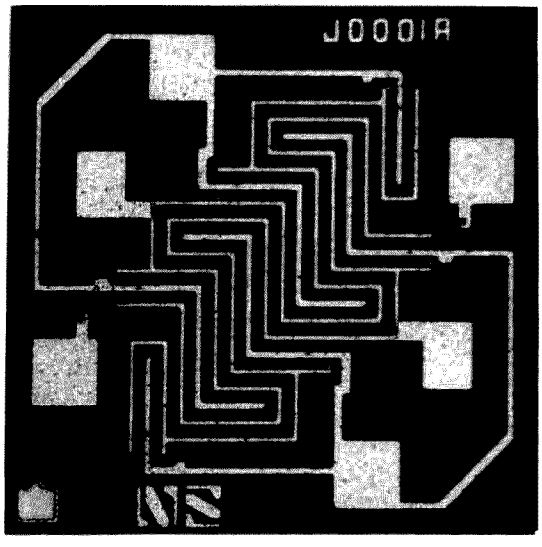


envelope to ensure permanently low and stable contact resistance, long life, low loss and inherently low noise level with no distortion. The Series 313 is supplied in a variety of alternate versions with various electrical and mechanical

characteristics. *Dow-Key Company, 2260 Industrial Way, Broomfield CO 80020.*

Monolithic, N-Channel, Dual FETs

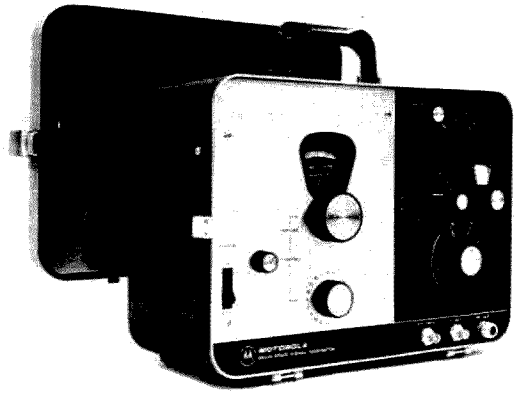
The FM3954 series are monolithic dual JFETs manufactured with special processing and a radical new departure in geometry. The geometries of both FETs are intertwined to obtain a perfect match. The series completely removes the prob-



lem of complicated testing because each dual die is a perfect match. Features of the series include very close tracking regardless of bias point, from 50 μA to 500 μA, low leakage of 100 pA and high gain of 1000 μmhos. *National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara CA 95051.*

Solid State FM Signal Generator

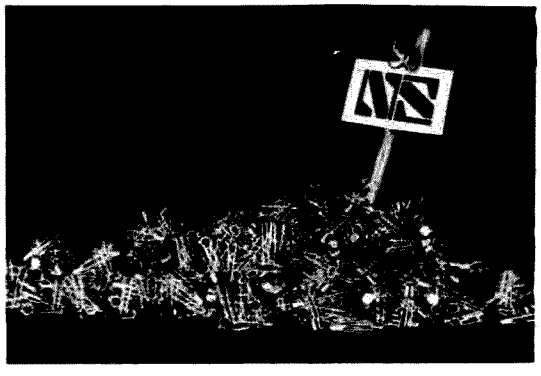
Electronic vernier tuning provides a more precise setting of frequency with or without



modulation for the solid state nuvistor oscillator, FM signal generator. Incremental electronic tuning allows the frequency to be adjusted 16 kHz either side of zero center. The unit's automatic level set now sets a "red line" reference automatically. External modulation and deviation sensitivity of only one volt input provides a full 16 kHz deviation eliminating the need for high powered external signal sources. *Precision Instruments Department, Motorola Communications & Electronics, Inc., 1875 Greenleaf Ave., Elk Grove Village IL 60007.*

Low Cost General Purpose FET Amplifiers

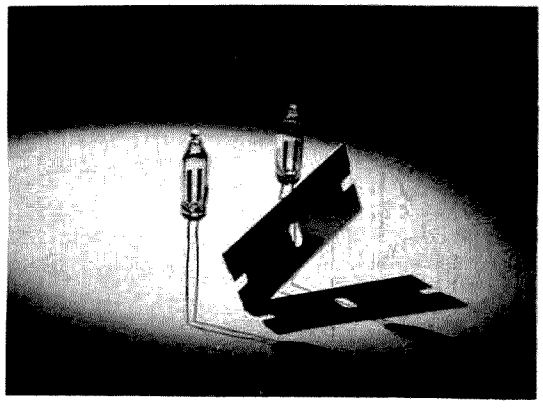
This group of low cost general purpose FET amplifiers offers outstanding performance in all types of amplifier applications due to their low noise (2.5 dB max), low leakage (100 pA max)



and low capacitance (2.0 pF max). They also offer low on-resistance. *National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara CA 95051.*

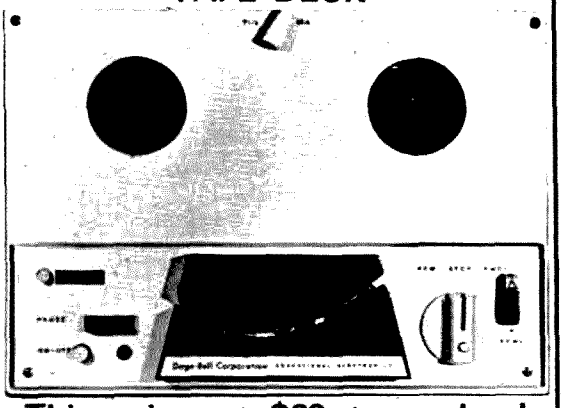
Neon Tube Repeatability In Timing Circuits

The close tolerance in breakdown voltage characteristic and the high leakage resistance of the A039A neon tube provides a high degree of repeatability when it is used in RC timing circuits. Breakdown voltage of the tube is 66–72 volts in the dark. Maintaining voltage is 50–60 volts at .3 mA. Leakage resistance of the A039A



is greater than 20,000 megohms. The A039A is 27/32" in length and .244" diameter. It is provided with 1" tinned leads. Where electrical characteristics are slightly different the A243 neon tube has a breakdown voltage rating of 68–76 volts and a leakage resistance of 10,000 megohms minimum. *Signalite Inc., 1933 Heck Ave., Neptune NJ 07753.*

TAPE DECK



This unit cost $69 to produce! We now offer a limited quantity of these new original packed tested units for only $29.95 plus shipping and handling.

On cash with order, shipment is made the same day of receipt of order for only $4.55 shipped P.P. Ins. anywhere in the USA. COD orders accepted, same prices plus COD fee.

LOOK AT THESE UNPARALLELED FEATURES NOT FOUND ON ANY OTHER DECK OF U.S. MANUFACTURE AT MUCH HIGHER PRICES.

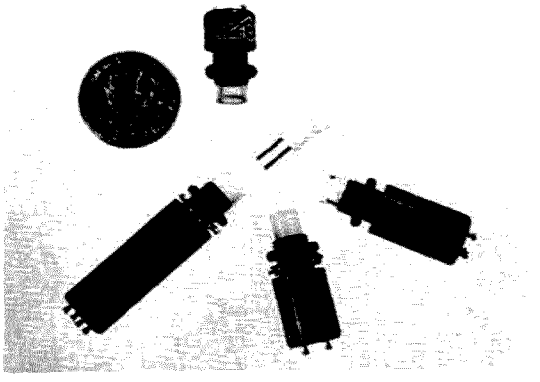
STOP–START: Full speed attained in less than 0.5 sec.
DRIVE CONTROL: Single rotary control for all functions. Interlock prevents tape breakage, stretching and spilling when changing mode of operation.
MOTOR: 4 pole shaded, 50/60 Hz.
BRAKES: Mechanical braking eliminates need for adjustments.
TAPE SPEEDS: 3¾ and 7½ ips.
WOW AND FLUTTER: Less than; .25% at 7.5 ips; .3% at 3.75 ips.
POWER: 26 WATTS', 120V 60 Hz.
DIMENSIONS AND WEIGHT: 10 5/16" x 14¼" x 5½" Below panel, 1½" above panel. 14 pounds.
REEL AND TAPE SIZE: 7" max. reel, ¼" tape.
HEADS: Record/playback staggered two track sterio, dual erase. (¼ track stereo erase, and R/P head available, $9.95 for complete kit).
COUNTER: Resettable 4 digit index counter.
R/P FREQUENCY RESPONSE: 40 to 15,000 cps ± 3 dB.

TAPE DECK ONLY
Electronics listed separately

WARREN Electronic Systems
BOX 73, CHICKASHA OK 73018

Subminiature LED Indicator Line

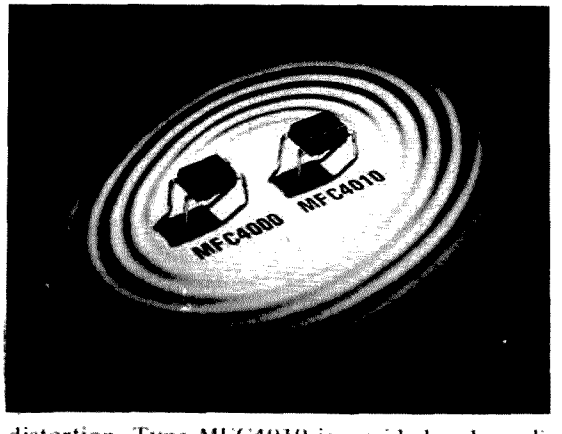
LEDs (light emitting diodes) are used as the light source for subminiature indicators and switch indicator devices. The "SS" series are resistant to shock, vibration and other environmental extremes. The body diameter is .360" and



3/8" mounting centers in a ¼" panel hole. Units mount from the rear and are secured by lockwasher and knurled nut. Turret lug terminals are provided. *TEC, Inc., 6700 South Washington Ave., Eden Prairie MN 55343.*

Inexpensive Integrated Circuits

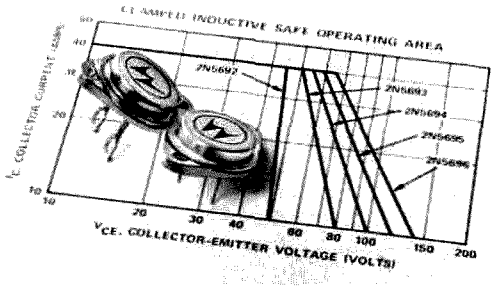
Two devices, Types *MFC4000* and *MFC4010*, are the first units in a line of inexpensive consumer integrated circuits. Type MFC4000 is a low-power audio amplifier featuring 250 mW of audio output power and low total harmonic



distortion. Type MFC4010 is a wide-band amplifier featuring high gain and low typical output noise. Both devices are housed in a four-lead plastic package. *Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix AZ 85036.*

Germanium Power Transistors

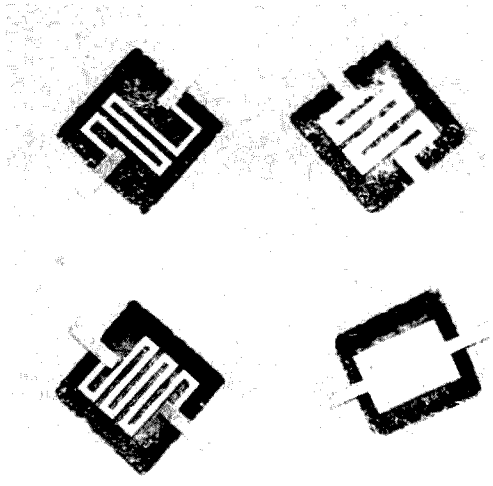
Types *2N5692 through 2N5696*, 40-ampere pnp germanium power transistors feature significantly improved safe operating area. Minimum collector-emitter sustaining voltages range from 50 to 140V at 10A, and from 45 to 65V at 40A. The series is ideal for use in voltage/current



regulators, motor controls, inverters, converters, and servoamplifiers. *Motorola Semiconductor Products Inc., Box 20912, Phoenix AZ 85036.*

Chip Resistors Feature Beam Leads

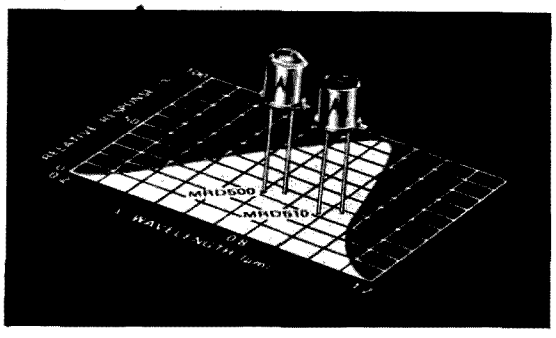
A series of unencapsulated resistors featuring small size (50 mil square) and gold beam leads, with resistance values ranging from 5 to 5000Ω, is offered by Motorola. The miniature resistors

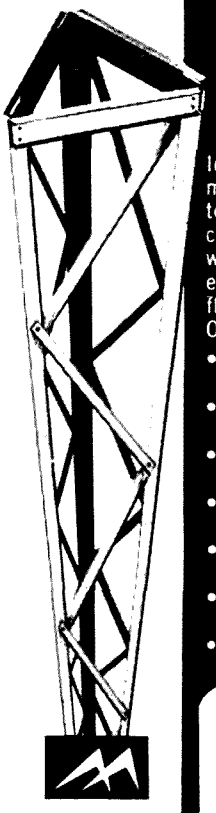


feature a temperature coefficient of 50 ppm/°C and maximum power dissipation of 125 mW. *Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix AZ 85036.*

Fast Photodiode has High Radiation Sensitivity & Low Dark Current

Featuring ultrafast response, high radiation sensitivity, low dark-current level, and low cost are two p-i-n photodiodes, *MRD500* and *MRD510*. Both devices are sensitive over a





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Ideal for mounting industrial, commercial, citizens band, amateur, or television receiving antennas. Exceptional strength in proportion to weight qualities. Easy access to equipment mounted on the Microflect top mast extension.
Other features are:

- 10 to 120 feet high in easy to erect 10 foot sections.
- Available factory assembled or in kit form.
- Lightweight all aluminum 10 foot sections weigh only 12½ lbs.
- Low maintenance, will never rust or require painting.
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– RF TOROID CORES –

Red "E" Cores – 500 kHz to 30 MHz, μ = 10

#	OD	ID	H	EACH
T-200-2	2.00"	1.25"	.55"	$3.00
T-130-2	1.30	.78	.44	2.00
T-94-2	.94	.56	.31	.75
T-80-2	.80	.50	.25	.60
T-68-2	.68	.37	.19	.50
T-50-2	.50	.30	.19	.45
T-37-2	.37	.21	.12	.40
T-25-2	.25	.12	.09	.30
T-12-2	.125	.06	.05	.25
Yellow "SF" Cores – 10 MHz to 90 MHz, μ = 8				
T-94-6	.94	.56	.31	.95
T-80-6	.80	.50	.25	.80
T-68-6	.68	.37	.19	.65
T-50-6	.50	.30	.19	.50
T-25-6	.25	.12	.09	.35
T-12-6	.125	.06	.05	.25
Black "W" Cores – 30 MHz to 200 MHz, μ = 7				
T-50-10	.50	.30	.19	.60
T-37-10	.37	.21	.12	.45
T-25-10	.25	.12	.09	.40
T-12-10	.125	.06	.05	.25

FERRITE BEADS: THE LITTLE GIANTS. μ = 900, Spec Sheet and Application Notes. Pkg. of 12: $2.00

KILOWATT BROADBAND TOROID BALUN KIT: $5.00

EXPERIMENTER'S 2 CORE TOROID KIT: Thousands Sold. Has cores, wire and charts & construction suggestions. Make your own High Q inductors for hundreds of modern uses: $1.50

MINIMUM ORDER: $3.00

Please add 25¢ per order for Packing & Shipping

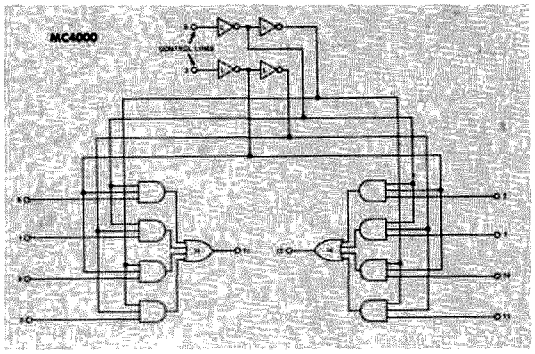
FREE ILLUSTRATED FLYER

AMIDON ASSOCIATES
12033 Otsego Street
North Hollywood, Calif. 91607

wavelength of 0.4 to 1.1μ, with peak sensitivity at 0.8μ. They also have a low series resistance of 10Ω max and a maximum total capacitance of 4 pF. *Technical Information Center, Motorola Semiconductor Products Inc., Box 20924, Phoenix AZ 85036.*

Data Selector Highlights High Speed

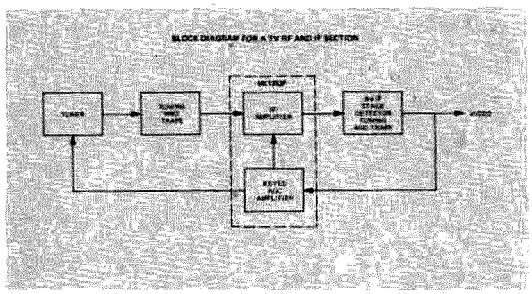
The dual four-channel data selector, Type *MC4000*, features high speed characterized by a typical propagation delay of 11 ns from data input to output. The selector consists of inter-



nally connected low-level inverters and high-level *and*—*or* gates. Data on any one of the four inputs is selected according to the binary code on the control lines and is routed to the output. *Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix AZ 85036.*

TV Video I-F Amplifier

Type *MC1352* TV video i-f amplifier has an integral keyed agc amplifier circuit in addition to the i-f amplifier circuit of the Type MC1350



device. It constitutes a complex TV i-f strip, resulting in cost reduction compared with discrete circuits. *Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix AZ 85036.*

De-RF Your VTVM

A partial schematic for a common vtvm is shown in Fig. 1. The modifications shown in the bold lines of the schematic allow the vtvm to be used near a strong rf field and can be added to almost any vtvm without affecting the accuracy of the meter.

This modification bypasses the rf to the bridge tube (12AU7), keeping the rf from driving this tube into grid rectification.

The capacitors used can be anything from .001 to .01 disc ceramic. They should

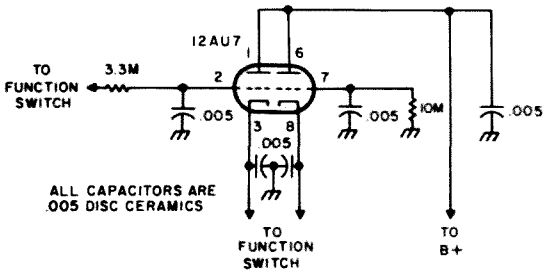


Fig. 1. A partial schematic for a common VTVM.

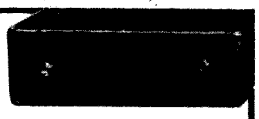
be mounted with short leads and returned to the same ground point. The capacitors which are already in the circuit need not be bypassed.

This modification was added to the Heathkit Model V5A vtvm and it is no longer affected by rf.

These modifications *do not* apply to an ac meter.

Jan Wilstrup, WAØFFJ ■

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MODEL 432CA
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Low Noise Silicon Circuitry ● Attractive Metallic Green Styling ● Built-in ac Power Supply ● Silver Plated Cavities ● Write for detailed literature or order direct, specifying i-f frequency.

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Getting Your Extra Class License

STAFF

Part XVII: Conclusion

All things end, the philosophers tell us, and this installment brings our study course for the Extra Class exam to its close. All we have left from the 90 questions on the official FCC study list are a half-dozen "miscellaneous" items covering a number of relatively minor but nevertheless important points.

The official questions which remain for us to examine are:

47. What useful functions does a balanced modulator perform in a radio transmitter?

69. What is a third party agreement? What countries have agreements with the United States?

83. Describe briefly how an ac power supply produces a dc output voltage. Discuss the merits of using choke-input versus capacitor-input filters in power supplies. How does the leakage resistance of the capacitors affect the output voltage? Also, what is voltage regulation as related to power supplies?

85. What is push-pull amplifier operation?

86. What is a Q-multiplier and how is it used in amateur equipment?

89. What visual observation within an operating vacuum tube's envelope would indicate that the tube is gaseous?

90. Be familiar with Part 97 of the Commission's rules.

Since these questions cover such a broad range of subject matter, we'll abandon our usual technique of rephrasing the FCC questions this time, and simply extend our looks a bit past the specific points asked. Keep in mind that the actual Extra Class exam may contain questions of similar nature on other parts of radio theory—but the official study questions are intended to provide adequate preparation for the "real thing" and any questions in radically different areas will probably be few and far between. All set?

What Does A Balanced Modulator Do?

The balanced modulator is generally considered to be a part of SSB or DSB equipment, although it doesn't necessarily have to be. The function of a balanced modulator is to mix (or heterodyne) two input signals into a group of output signals; so far, that's the same as the function of any other kind of modulator or even a receiver mixer stage.

But the balanced modulator differs from a conventional modulator in one essential particular. Where a conventional modulator or mixer produces *four* signals in its output—

the original "carrier," the modulating signal, and the sum and difference of these two inputs (generally called the upper and the lower sideband)—the balanced modulator has only three parts to its output. The "carrier" is suppressed by being "balanced" out, and the output contains only the modulating signal and the two sidebands.

In a radio transmitter, the modulating signal is usually at audio frequency while the carrier and the sidebands are at rf. The af is not coupled out from the mixer stage, so that a conventional modulator's output (after the coupling) contains only the carrier and the two sidebands.

A balanced modulator's modulating-signal output is similarly disposed of in the output coupling circuit, and the carrier signal is balanced out in the modulator circuit, so that the effective output of a balanced modulator in a radio transmitter consists of *only* the two sidebands. In a phrase, the balanced modulator produces a DSB signal.

Because the carrier disposal is accomplished by built-in circuit action, rather than by filters, a high degree of carrier suppression can be achieved. It's limited primarily by the care taken in adjusting the circuit, and by the shielding which prevents stray carrier-frequency signal from leaking around the circuit; the balanced modulator stage itself is capable of "perfect" rejection of the carrier in theory at least, and in practice 30 to 40 dB of suppression is normal.

For this reason, almost all SSB transmitters use some balanced modulator circuit to generate the original SSB signal. "Phasing" designs use a pair of balanced modulators, in which the phase relationships between carrier and modulating signal differ, so that the individual outputs of the two balanced modulators will add together for one sideband and cancel out for the other. "Filter" designs depend upon filter selectivity to reject the unwanted sideband, but the balanced modulator's rejection of the carrier together with frequency shaping in the audio channel before modulation provides a region near the carrier in which little or no signal is present, and thus eases the task of the filter designer.

The balanced modulator has another feature which comes along automatically at no extra charge. Since carrier suppression depends upon the fact that the modulator *is* balanced, all that's necessary to put some carrier in is to deliberately unbalance the modulator. This permits carrier insertion, which is sometimes handy to have.

Balanced modulators aren't restricted to SSB and DSB transmitters, either. The Armstrong technique for producing FM (it actually produces a mixture of phase and frequency modulation, but it's the system normally used by FM broadcasting stations) also makes use of balanced modulators. If the carrier is removed from an AM signal, shifted in phase by exactly 90 degrees, and then reinserted into the signal, the result is PM. If audio frequency response is properly shaped, the PM which results cannot be distinguished from FM by any method. The Armstrong technique uses a balanced modulator to simultaneously produce the AM signal and remove its carrier, and a separate phase-shift network to shift carrier phase by the necessary 90 degrees. The carrier is then reinserted, and the result is FM—but crystal-controlled. This technique is seldom used by hams because we have no need for a wide frequency swing in our FM signals, but it's the mainstay of commercial FM broadcasting.

A number of balanced-modulator circuits exist. They range from simple diode-ring switches, in which the carrier signal acts as a switch to steer the modulating signal through coupling networks (or vice versa, with the modulating signal switching the carrier), up to push-push amplifiers. A typical amplifying balanced modulator using tetrode tubes is shown in Fig. 1. In this circuit, the carrier is applied to both control grids in push-pull while the output is taken from both plates in parallel. With no modulating signal present, any increase in current through one tube (caused by the carrier waveform's going positive) is balanced out by a corresponding decrease in current through the other tube, because the waveform at its control grid goes negative by the same degree. Therefore the carrier is balanced out of the output circuit, and nothing emerges from the plate tank.

When a modulating signal is applied to the screen grids in push-pull, though, the

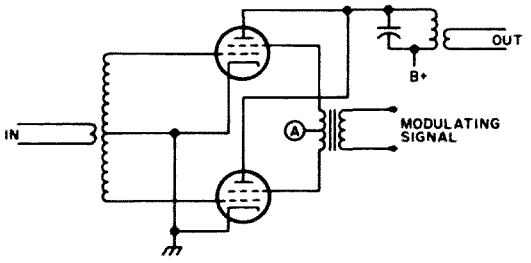


Fig. 1. This oversimplified schematic of a tetrode balanced modulator is intended to show only the operating principle. All arrangements for tuning the grid circuit, supplying grid bias, and bypassing the screens have been omitted. Carrier input applied to the terminals labeled "IN" goes to the two control grids in push-pull, and balances itself out so that none emerges in the parallel-connected plate circuit. When modulating signal is applied to the screens, also in push-pull, the circuit's balance is upset and sidebands are not canceled out. Point "A" may be returned to ground, to a slightly negative voltage, or to a slightly positive voltage, depending upon the tubes used. It should not connect to a normal screen-voltage level, since full screen voltage in this circuit would cause excessive power dissipation in the tubes.

two tubes no longer operate under identical conditions if any modulating signal is present. If a modulating signal drives one screen slightly more positive, it will at the same time drive the other screen slightly more negative. The carrier signal is no longer balanced out as a result. When the tube with the positive screen gets positive control grid voltage as well, it draws correspondingly more current than the other tube; the net change at the plate tank circuit is a slight increase in current.

As both modulating and carrier signals vary in polarity and strength, the power in the plate tank circuit will vary. The net result is that no power gets out at carrier frequency, but the signal components at both the sum and the difference frequencies (or in the upper and the lower sidebands) do appear and can be coupled out.

This circuit was popular as an "instant" DSB transmitter when double sideband was first pushed some 10 years ago; it still has its uses.

A similar circuit using only one tube, called a "beam deflection tube," has been used as a receiver mixer and as a product detector, as well as for color demodulation in TV receivers. The stereo multiplex circuits in quality FM receivers also make use of balanced modulators to recover the stereo signal and route it to the appropriate channel. But these uses are outside the range of the FCC question, which deals only with "useful functions" in a radio transmitter.

What Are Third Parties? The phrase "third-party traffic" is frequently encountered both on the air and in the ham literature, not to mention its occurrences in the FCC rules and international regulations. What is it all about?

The "third party" does not refer to political innovations. It's a legal phrase similar to "the party of the first part" and "the party of the second part," and it has a most specific meaning in regard to ham radio.

In any QSO, only two parties are involved; they are the ham who is talking (or transmitting), and the one who is listening (or receiving). A "third party" is anyone else other than one of these two.

It might appear that a roundtable or net operation would have more than two parties, but in any properly operating net or roundtable only one person transmits at any given time. He is the first party, and all the other participants (collectively) are the second party. Again, a "third party" is anybody on the outside.

The international rules governing radio communication include a specific prohibition forbidding amateur stations from handling any kind of traffic or messages on behalf of "third parties." This means that, so far as this rule is concerned, you can't tell the guy on the other end to give your regards to his family—for his family is a third party to the conversation. You might argue that the message is on your behalf, not theirs—and you *might* get by with this argument. But you certainly would not be safe in sending *your* family's regards to *his* family.

This rule came into being because, in most countries, the radio communications facilities are government-owned, and the governments which created the rules feared that ham stations might compete with the government monopolies on traffic handling. In this country, of course, the commercial radio communications services are privately

owned rather than being parts of the government, and so this nation has not been an enthusiastic supporter of the "no ham traffic" movement.

In fact, that same rule which generally forbids third-party messages through ham stations includes a loophole, to the effect that the rule may be suspended by mutual agreement between two nations, so far as the hams of those nations are concerned. This part of the rule was written to satisfy U.S. requests, in part at least.

A "third-party agreement" is such an agreement between two nations that their hams may handle third-party traffic. This country has third-party agreements with about 30 other nations, and message traffic can be handled to and from those countries. Messages within this country can, of course, be handled without third-party restriction because this government has chosen to permit them. The exact list of nations with which third-party traffic may be handled varies from time to time, as new names are added (and occasionally, old ones taken off when agreements are canceled for one reason or another). Check a current list just before going for the exam to be sure.

Power Supplies. Every item of electronic equipment requires a power supply of some sort. The pocket transistor receiver is probably the simplest in this respect, because its power supply consists of a single dry-cell battery (usually the 9V size). Most of our ham equipment, however, is not so simple nor so portable. Producing 1 kW of dc input to a transmitter requires several kilowatts of power, and the supply which does this job is a bit bulky.

Power supplies in general can be grouped into three main classes. The first, typified by the transistor set, gets power directly from expendable batteries. It's dc to begin with, and it's also at the proper voltage. This type of power supply is simply one or more batteries, and we can ignore it from here on.

The second class also operates from a battery, but gets all its various output voltages from a single rechargeable battery which is normally of comparatively low voltage. The mobile rig's vibrator or transistorized supply is an example of this type. It's fairly complex, but once the low-voltage dc from the battery is changed to either ac or a pulsating dc (either of which will go through a transformer nicely), it becomes much the same as the third class.

The third type, which we'll examine in some detail here, operates from ac input. The normal ac input voltage is either 117V from a wall plug, or 220V from a 3-wire connection. The output voltages may range from a few volts (to replace the battery in a transistor set) up to several thousand volts. The ultimate output is dc, but its "purity" may range from being almost completely free of hum, ripple, and noise, just like a good battery, to being almost ac and qualifying for the "dc" label only because current flow never reverses.

The ac power supply consists of three major sections: the transformer (which changes the input voltage to the appropriate voltages for the desired outputs), the rectifiers (which convert the ac to pulsating dc), and the filter (which removes the pulsations from the dc and smooths it into something approximating "pure dc").

The transformer in the power supply establishes the maximum output voltage and current available. While it's possible to cut down the output voltage by resistors, it's wasteful of power and components to do so, and as a result the transformer is normally chosen to produce the proper output voltage rather than merely letting it set the maximum. The relationship between rms ac voltage at the transformer secondary, and dc output voltage, depends on both the rectifiers employed and the type of filter circuits used. In general, the dc output will almost never (with conventional rectifier circuits) be more than 1.5 times the rms ac voltage at the secondary, and will seldom be less than the rms ac value.

The ac from the transformer secondary is applied to the rectifier circuit. Most transformer-type supplies use full-wave rectification; most of these, in turn, use the center-tap circuit which requires two rectifiers. Each rectifier anode connects to one end of the transformer secondary. The center-tap of the secondary is the negative terminal for the dc output, and the cathodes of the rectifiers (which are connected together) provide the positive terminal.

Some full-wave rectifier circuits use the bridge circuit, which takes four rectifiers but needs no center-tap on the transformer secondary. If a bridge circuit is used with a transformer which was designed and rated for center-tap circuits, the secondary voltage to figure on is that from end to end of the winding, rather than from one end to center tap. This means that a secondary rated (as so many TV transformers are) at 350-0-350V would give 700V end-to-end, and with a bridge circuit could be expected to produce a dc output voltage around 900 to 1100 volts.

Sometimes a half-wave rectifier circuit is used. This takes only one rectifier, but is neither as efficient in its use of the ac nor as desirable in terms of simplicity of filtering as a full-wave circuit. The half-wave circuit simply blocks off half of the ac waveform and lets the other half pass through; the result is dc output which pulsates at input ac frequency. All it really is is a string of half-cycles of the input ac. A full-wave circuit, whether center-tap or bridge, passes both halves of the ac waveform, but steers them around so that they emerge always going in the same direction. This produces twice as much power with less strain on the rectifiers, and also makes the ripple frequency be twice the input frequency—which means it's easier to get rid of the ripple.

The filter circuits make use of capacitors to store the pulsating dc and smooth out the ripple. Sometimes, the capacitors are the only elements in a filter, but by themselves capacitors don't do much filtering. If inductors or resistors are placed in series with the load while capacitors are in parallel with it, the inductors will oppose any changes in current while the capacitors tend to smooth things out, and almost pure dc can be obtained.

The two most commonly used filter circuits are shown in Fig. 2. The only difference is that in one, the input element is a capacitor, and in the other, an inductor or choke.

This single difference provides the names for the circuits: "capacitor input" and "choke input." While the circuits are extremely close to each other in appearance, they have some notable differences.

A capacitor, when discharged, is almost a short circuit even to dc. It's only after the capacitor reaches nearly full charge that the current flow into it comes down to small levels. A capacitor-input filter, then, represents almost a dead short to the transformer and rectifiers when power is first turned on. The larger the capacitor, the worse the short—yet it takes a large capacitor to do much smoothing. One of the major characteristics of a capacitor-input filter is the enormous power surge into the input capacitor when power is applied the first time.

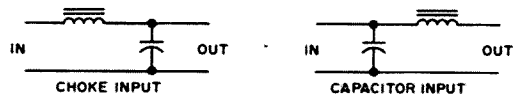


Fig. 2. The two basic types of filter sections used in power supplies are shown here. Note that both are lowpass filters, and could be designed by normal lowpass techniques if one deisred. However, the frequency-cutoff requirements in a power supply filter are most uncritical, and so the complexity of audio filter design is unnecessary. The only requirements are that the choke's inductance, and the capacitor's capacitance, both be large enough to reduce ripple to acceptable terms A single section of filtering usually reduces ripple by about 95%; two sections will reduce ripple by 0.95 times 0.95, or 99.75%. More than two sections are seldom used.

As power is taken from the supply, it tends to discharge the filter capacitors, and so with each cycle of rectified ac there's still quite a charging-current flow into the capacitor. A capacitor input filter will, then, draw more current from the transformer (for a given dc load) than would some other type.

This is generally considered to be a disadvantage, but it has a compensating advantage. Under light current load, the input capacitor will charge up to nearly the peak voltage of the rectified ac, which is 1.4 times the rms voltage. With light current loads, the voltage will remain near this peak. Thus a capacitor input filter produces a higher output voltage—provided that load current is low. As load current increases, the capacitor voltage drops, and the advantage is lost.

A choke opposes any change in current flow, and so the choke-input filter tends to retard the high current flow into the filter

capacitor. This reduction of charging-current surges means that less current is taken from the transformer to keep the capacitor charged, and so more is available to the load. For the same transformer, a choke-input filter can deliver more current.

Offsetting this advantage, in some applications, is the fact that the choke (by slowing down the charging) prevents the capacitor from ever charging up to the peak voltage value if any load current is coming out. Thus a choke-input filter delivers more current, but at lower voltage.

Complicating the action of the choke-input filter is the fact that a certain minimum current *must* be drawn through the filter to make the choke behave as intended. The bleeder resistor value is chosen so that this minimum load is always taken; this power is "wasted" insofar as producing any useful work is concerned.

Most power supplies use at least two filter capacitors separated by a series choke. If choke input is employed, two chokes are used. Because of the additional reactance of the second choke, ripple is usually lower from the choke-input design; if a corresponding reactance were added to the capacitor-input filter, its ripple would be reduced equally.

The output element of all filters is a capacitor. It performs little filtering action in most cases; its purpose is to serve as a storage reservoir to satisfy sudden surges of load current and keep output voltage from falling when this happens. That is, it helps determine the "voltage regulation" of the supply. The larger the value of output capacitor, the better the regulation, in general.

"Voltage regulation" in a power supply is the change in output voltage with changes in load. Any supply will produce higher output voltage when it is unloaded than it will under heavy load. The change in voltage from maximum to minimum is called the "regulation" of the supply and is often expressed as a percentage. Just what this percentage refers to differs from one engineer to the next. Some obtain the percentage by taking the *change* in voltage as a fraction of the minimum voltage, some get it by taking the change as a fraction of the maximum voltage, and some get it by taking the ratio of minimum to maximum.

This can lead to most conflicting descriptions of the same power supply. Let's assume we have a supply which produces 200V without load, and under maximum load the output drops to 150V. This is pretty poor regulation by anybody's standards, but let's see how the three ways of figuring it would differ. The first method would take the change, 50V, as a fraction of minimum, or 150V, and report a regulation of 33-1/3%. The second method would take 50 as a fraction of maximum, 200V, and report 25%. The final way would take the ratio of minimum to maximum, 150/200, and come up with 75%.

If minimum output was 20V (yes, that is an extreme case), the first way would call the regulation 180/20V or 900%, the second way would call it 180/200 or 90%, and the third way would call it 20/200 or 10%. You can see that the phrase "voltage regulation" expressed as a percentage means very little, unless the quantities composing the percentage are specified. The second method is the one most widely used, but the first and third are encountered frequently enough to make one treat them all with caution.

Since capacitors are a vital part of all power-supply filters, and all capacitors have leakage resistance, it's important to know what effects this leakage resistance may have upon the operation of the filter.

If the leakage resistance is high, there is almost no detectable effect. However, many power-supply filters use electrolytic capacitors, which tend to have much lower values of leakage resistance than do paper or oil types.

If leakage resistance is low, it will produce extra load on the power supply, drawing additional current through the transformer and the rectifiers. This added load will tend to reduce the output voltage, and may cause overheating of all power-supply components. In addition to these effects, the leakage resistance acts as a shunt across the capacitor, thus reducing the effective value of its capacitance and making its filtering action less effective. You might say that an extremely leaky filter capacitor is something

like a sieve; neither of them are very useful as storage devices.

The leakage resistance of electrolytic capacitors varies with the capacitor's age. As an electrolytic ages, its leakage resistance usually goes down, making it less useful.

Fortunately (in a roundabout way), the effects of excessive leakage tend to be self-destructive. As abnormal leakage currents overheat the capacitor, it becomes even more leaky. Finally, the point is reached at which the capacitor literally explodes from internal heat. This removes the capacitor from the circuit, and in most power-supply designs nothing else in the supply is damaged (although the inside of the chassis becomes somewhat messy). The violent action *is* desirable, since it prevents the capacitor's turning into a dead short which might destroy transformer and rectifiers as well, and it leaves no doubt as to the identity of the failed component.

What Is Push-Pull Amplifier Operation?

A push-pull amplifier is actually two amplifiers working together, with input and output signals arranged so that plate (or collector) current in one of the two increases at the same time that of the other decreases. In industrial electronics, this same circuit is often called a "differential amplifier" or "diffamp" for short.

The input and output arrangements which are the heart of push-pull operation involve driving half of the stage with a signal which is exactly 180 degrees out of phase with the signal applied to the other half, and reversing the phase of one of the output signals by 180 degrees before combining them.

The most conventional method of obtaining the out-of-phase input signals, and of reversing phase of one output signal with respect to the other, is by using center-tapped transformers at input and output. The phase reversal is inherent when the signals are taken from opposite ends of a single center-tapped winding, with the center-tap used as a common reference point.

Transformer coupling is actually not necessary for push-pull circuits to operate. Especially in audio frequency amplifiers,

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where a wide frequency response may be needed, a special "phase inverter" circuit may be used to generate two signals of equal amplitude but opposite phase. These signals may then be fed individually to the two halves of a push-pull amplifier, and the two outputs from that push-pull stage used to drive another push-pull stage. The cascading of push-pull stages may continue indefinitely. At the output, another phase-inverter circuit could restore the signals from each half to the same phase. In practice, however, a transformer is usually used at the output if vacuum tubes are being used, because phase inverters capable of handling appreciable power levels with vacuum tubes are not common.

Push-pull transistor amplifiers may be similar to their vacuum-tube cousins, but when transistors are involved, it is no longer necessary to use either transformers *or* phase inverters. This comes about because transistors come in two flavors of opposite polarity: PNP and NPN. A signal which would increase current in a PNP transistor would decrease current in an NPN. To build a push-pull transistor amplifier, then, no phase inverter at the input is necessary. Just parallel two stages, using a PNP transistor in one and an NPN in the other, and the outputs will automatically be push-pull if the transistors' characteristics are matched.

This quality (and design trick) carries the polysyllabic name of "complementary symmetry," and several sets of PNP-NPN paired types have been designed for just such applications.

At the output, a similar trick can be employed, using what someone several years ago dubbed the "totem pole" configuration with two transistors in series, and output taken from the midpoint. The circuit for such an output stage is shown in Fig. 3. This circuit is adapted from one which has appeared in several editions of the GE Transistor Manual, and hardly anything in it is particularly critical. With conventional 150 mW transistors, it can produce up to 2W of audio, which is surprisingly loud and clear.

Push-pull amplifiers have a number of advantages for audio and whenever linear amplification is necessary (as for SSB). The

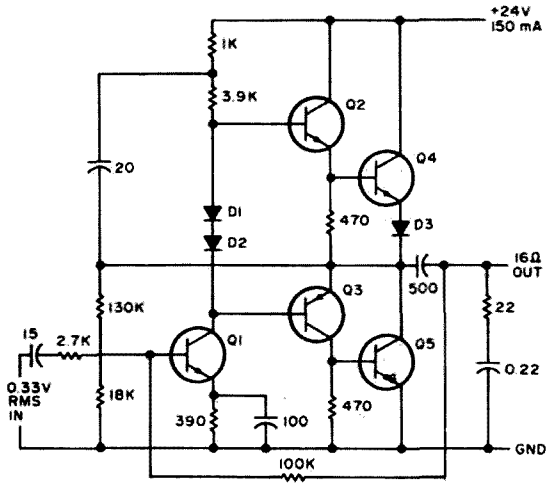


Fig. 3. This circuit for a 2.5W af power amplifier illustrates complementary-symmetry phase inverters (Q2 and Q3) as well as totem-pole output circuit (Q4 and Q5). Transistor Q1 is simply a preamp to provide drive to the phase inverter stage. A 100 kΩ resistor at bottom provides negative feedback. Diodes compensate for base-emitter voltage drops of transistors, making dc coupling safe to use. Transistors Q4 and Q5 must handle 800 mW dissipation; type 2N3402 transistors are simply 2N3414's with built-in heatsinks to raise power rating and are recommended for Q4 and Q5.

advantages are less pronounced when simple rf power amplification is needed, but some are still present.

One of the major advantages of the push-pull amplifier arrangement is the fact that it is a "balanced" amplifier. Any signals which are *in* phase with each other in both halves of the circuit, such as hum in the dc power supply, tend to be balanced out and are not passed on to the output. The same is true of second-harmonic distortion, and for that matter of all even-order distortion products.

The reduction of second-harmonic distortion because of its being balanced out permits us to choose between having less distortion for the same power output (the path taken by hi-fi designers) and having more power output from the same tubes without passing an objectionable distortion figure (the route taken by most hams).

The push-pull arrangement also permits us to operate the tubes or transistors over a wider range of conditions than would be possible with a "single-ended" stage. The class B amplifier is the extreme example of push-pull operation; a class B audio amplifier *must* employ the push-pull circuit to pro-

duce a recognizable output signal, since each half of the circuit works on only half the waveform. The popular class AB amplifiers are based on the same principles, only not to such an extreme degree.

With class C operation, these advantages disappear. The balancing out of second-harmonic distortion is still present, though, and permits us to emit a cleaner signal than we could from a comparable single-ended stage. Neutralization of a push-pull stage is also usually simpler than for a single-ended one, since the required out-of-phase neutralizing voltages are already present in the "other half" of the amplifier.

The Q-Multiplier

Although the Q-multiplier has been with us, under that name, since about 1950 or so (and under other names since the first vacuum-tube receivers were used in ham radio!) its operating principles remain a mystery to many of us.

This isn't too surprising, because it seems almost unbelievable that any device can be connected to a receiver by a single wire which serves as both input and output connection, and produce either a dramatic boost to one signal without affecting others, or an equally dramatic decrease in level of one signal (again without affecting the others).

And this bit of black magic is just what a Q-multiplier circuit does. It connects into the i-f amplifier strip of a receiver by a single connection, and you then have the choice of boosting one signal above the rest, notching out one signal, or having the device do nothing. The secret of this capability is an old friend to constant readers of this series—feedback. While uncontrolled feedback is normally a rather horrible and all-devouring monster, controlled feedback is, like fire, one of our most versatile tools. The Q-multiplier circuit is a device for generating and inserting a feedback signal, with complete control.

The name of Q-multiplier comes from the apparent effects of the circuit: When it is connected across any tuned circuit, the Q of that tuned circuit appears to be multiplied enormously (if the Q-multiplier is set to "peak" a frequency).

What the circuit actually amounts to is a way of picking out a sample of the signals present, and feeding them back over the same wire with controlled amplitude and phase. If the "peak" function is in use, the phase of the signal sent back to the i-f strip is such as to produce positive feedback, or regeneration. If the "null" function is selected, the phase is reversed to provide negative feedback, or degeneration.

The Q-multiplier contains, within itself, a tuned circuit of high Q to which the regeneration is also applied. This tuned circuit inside the Q-multiplier effectively substitutes for the original tuned circuit in the receiver, when the "peak" function is selected. The signals to which the Q-multiplier's internal tank circuit are tuned are not affected by the Q-multiplier at all, but any signals at adjacent frequencies (which would have been passed by the original receiver tuned circuits) are shunted out by the much higher selectivity of the internal tank.

When the "null" function is selected, the operation is a little bit different. The signals to be notched out are amplified by the internal tank just as in the "peak" operation, but they then pass through a phase inverter inside the Q-multiplier before returning to the i-f strip. The signal which was peaked up by the internal tank is, of course, the only one which goes through the phase inverter because the tank's selectivity has eliminated all the others from consideration, so it is the only one which is reversed in phase. When this signal in reversed phase is returned to the i-f strip, it cancels out the original signal. The other signals in the i-f passband are not affected, though. The result is to notch out the signal to which the Q-multiplier is tuned, without effect on the remaining signals.

The confusing part about operation of such a circuit, in either mode, is the fact that input and output travel over the same wire. How, then, if phase has been reversed for the "null" function, can the signal be present as an "input" to produce the action?

To explain this, we'll have to digress slightly into general servomechanism theory. While most persons think of "servos" as mechanical items in airplanes, or something equally far from ham radio, in truth any

circuit using controlled feedback is a servomechanism. A "servomechanism" is defined as "an object controlled, either in whole or in part, by the effects of its own operation"—and since feedback produces at least partial control of a circuit's operation by the effects of the output, it qualifies.

In a servo, the normal situation is to establish a "reference" signal. The servo's output is then compared to the reference, and an "error" signal results which tells how far the actual output is from the desired reference output, and whether it is greater or smaller. The error signal is then applied to the control portions of the servo, which are set up so as to attempt to drive the error signal to zero. If this occurs, it means that the actual output and the desired output are identical.

But, unfortunately, if the error signal ever does actually get down to zero, the servo is no longer controlled. The only thing holding it under control is the error signal's existence, and when it does succeed in forcing the error to nothing at all, the control disappears at the same time. Such a situation is known as "dither," "jitter," or "hunting." With no control, the servo circuit may do anything. As soon as it does, of course, the error signal reappears, and control is restored, but if the error signal is allowed to reach zero very often, the output will fluctuate whenever it does so. The "hunting" or "dither" describes the action which results.

The standard way to prevent the problem is to introduce just enough delay into the servo's feedback loop so that no matter what happens, the error signal can never completely disappear. This assures that hunting cannot occur, but the feedback will still make the error signal as small as it possibly can. In most cases, this is too small for us to measure directly. If we tried to do so, we would conclude that the error signal had indeed vanished—but the fact that hunting is absent indicates that enough error signal remains to keep the circuit controlled.

The Q-multiplier is a servo, of course, and when we set it up for the "null" function, we are in effect setting up the input signal-to-be-notched-out as the error signal. The circuit picks this specific signal out of its many possible input signals, and reverses its phase to cancel it out. If it should succeed in complete cancellation, there would be no input left to reverse in phase, and action would fail. As soon as this occurred, though, the reappearance of the signal would put the circuit back into play. The net result is that the notched-out signal is *effectively* canceled, but just enough of it remains to permit the circuit to operate. The process is aided by the fact that the voltage and current waveforms of ac signals are not necessarily in phase with each other, and so the voltage waveform can be canceled while leaving some of the current waveform untouched. The necessary error signal can then be obtained, inside the Q-multiplier, by converting this current back to a voltage.

A somewhat similar circuit operating at audio frequency and using RC phase-shift networks rather than a tuned circuit is known as the "Select-O-Ject." It operates in essentially the same way, to produce the same result but at audio frequency rather than at i-f.

Since the width of the peak, or of the rejection notch, is proportional to the frequency at which the circuit operates, both types of circuits serve useful purposes. The Q-multiplier can select one desired phone signal out of several in the passband, or can reject one which may be causing interference. The Select-O-Ject can peak up the desired beat note for CW reception, or can reject a heterodyne caused by a carrier just off the signal you want.

Either is often used to substitute for a crystal filter in a communications receiver. The circuits, being based on active devices, can be produced at less expense than can crystal filters, and in addition they are capable of some operations which crystals cannot do (such as notching out interference which is almost exactly on top of the desired signal). One feature of these circuits which has not been emphasized much is the fact that any number of them can be connected to a receiver with little if any interaction. This permits several different functions to be in use at the same time, such as peaking up one desired signal, notching out another which is still causing interference, and (with the audio version) slicing out several remaining traces of carrier whistle. However, oper-

ation of several at the same time might require the services of several trained octopi. . .

What Indicates A Gassy Tube?

From time to time we are impressed by the "gobbledegook" turned out in Washington, and the question in the FCC study list on which this discussion is based is one of the more notable gems: "What visual observation within an operating vacuum tube's envelope would indicate that the tube is gaseous?"

Apparently the anonymous government employee who worded this question was so fearful of using "jargon" in the list that he avoided the normal technical phrase "gassy" to describe a tube containing unwanted gases rather than the normal high vacuum—but the word he chose to replace it, unfortunately, does not mean the same thing. Since the three states of matter are solid, liquid, and gaseous, we would have to assume on the face of things that the tube under consideration is neither solid nor liquid. In that case, the most likely visual indication would be an inability to see the tube, wouldn't it?

However, we don't think that is what they really meant. It appears much more likely to us that they really want to know how you can tell a tube has gone gassy by looking at it—and Washington is not alone in sometimes using two dozen ten-pound words where a half-dozen everyday ones would do better.

Tubes go gassy for a number of reasons. The most normal is for some of the chemicals in the coating of the cathode to eventually break down under the high temperatures at which the cathode operates, and release gases. At least as frequent, though, in ham operation, is for the tube to be overloaded to such a degree that one or more of the tube's elements is actually vaporized, thus releasing gas. Screen grids of beam-power transmitter output tubes are particularly prone to this occurrence.

When a tube goes gassy, it no longer operates as it was intended to. The grid cannot control current flow when the gases ionize. This characteristic is made use of deliberately in the thyratron tube, and in a

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different way in the controlled rectifier. In general, though, a gassy tube must be replaced.

When a tube does go gassy, it usually lets you know immediately by glowing bright blue. This blue glow is produced by the gas ionizing under the impact of the electron stream, and is the most obvious visual indication of gassiness.

However, not all tubes which show a blue glow are gassy. If the glow is only at the inside of the glass envelope, it's more likely to be a fluorescence of the glass itself under electron bombardment. Many modern tubes show this effect, but it does not indicate gassiness.

Some tubes, also, exhibit a faint blue glow in the space between the cathode and the plate, even when operating normally. This is, again, fluorescence, but this time it's from the tube elements themselves.

The glow of a gassy tube, on the other hand, fills the space from cathode to plate, and is much brighter than any glow in a normally operating tube.

Some high power transmitter power supplies use mercury vapor rectifiers. These rectifiers are built with gas in them, and use it as a part of their normal operation. They also serve as perfect examples of what a gassy tube looks like. If any tube which is *not* a mercury-vapor rectifier begins to look like one, it has probably gone gassy. Or, if you prefer, it "is gaseous."

Rules and Regulations

The final question on the study list isn't a question at all, but an admonition: "Be familiar with Part 97 of the Commission's rules."

In this study course, we have taken great care to sidestep the details of the rules wherever possible, for one major reason. While the details of radio theory remain relatively constant, and are just as true today as they were five years ago or will be five years hence (although new discoveries may alter a few of the fine points, or provide additional understanding), this is not true of rules and regulations.

Rules and regulations are constantly subject to change. Right now we are in a period of transition which sees the permissible operating band limits changing every year—and a number of petitions before the FCC to make other changes.

Our intent in publishing this study course was to provide reference material. To do this, we felt it necessary to concentrate on that part of the examinations which would not be subject to change at the will of a regulating agency.

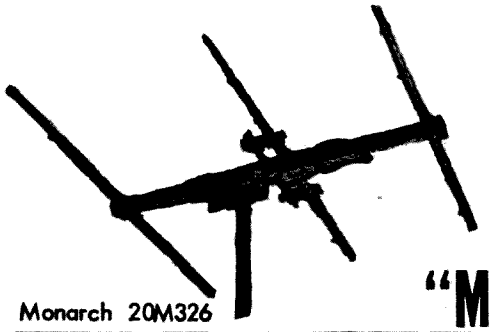
But it *is* important that you know the rules and regulations, as they exist at the time you take the test, if you want to succeed in obtaining your Extra Class ticket. While most of the emphasis is on theory, the fact remains that the top grade license requires a top grade of knowledge in every facet of ham radio.

So, before taking the exam, get a copy of at least the pertinent parts of Part 97 of the FCC rules and regulations, and brush up. You can order Part 97 complete from the Government Printing Office, or you can buy an up-to-date edition of the ARRL license manual. If you don't like spending money, you may be able to find a copy of Part 97 in a large library or in the files of some friendly commercial radio installation (FCC rules are bound in volumes, and normally you can buy only a complete volume; many commercial installations have copies of Part 97, as a result, in the volumes which they bought to get the rules applicable to their own service).

Key things to know are the effective band limits for each class of license and for each type of emission (and don't forget the UHF and EHF bands while you're at it), the restrictions which may be applied to ham operation and why, and the prescribed procedures for identification of all kinds of ham signals. Also important are the restrictions on types of messages which may be transmitted and received, and under what conditions these restrictions may not apply. Notification of portable and mobile operation, operation by aliens, and operation away from the U.S. jurisdiction may also be items worth being up to date on.

So there you have it. Good luck, and congratulations to you for your determination to obtain the top grade of all ham licenses.

. . . Staff ■



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$695.00	20M546	5 ELEMENT ROTARY	13.0 DB	30 DB	48°	8.0 KWP	3.50 x 3"x46'	150 Lbs.	36'-0	29'	450 Lbs.	14.0 Sq. Ft.	130 MPH
$795.00	20M646	6 ELEMENT ROTARY	14.0 DB	30 DB	46°	8.0 KWP	3.50 x 3"x46'	176 Lbs.	36'0	29'	530 Lbs.	17.0 Sq. Ft.	130 MPH
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$745.00	40M 335	3 ELEMENT ROTARY	8.7 DB	30 DB	58°	8.0 KWP	3.50 x 3" x35'	150 Lbs.	64'-0	36'-0	480 Lbs.	12.5 Sq. Ft.	130 MPH
$1110.00	40M346	3 ELEMENT ROTARY	9.0 DB	30 DB	57°	8.0 KWP	3.50 x 3" x46'	177 Lbs.	64'-0	40'-0	490 Lbs.	13.5 Sq. Ft.	130 MPH

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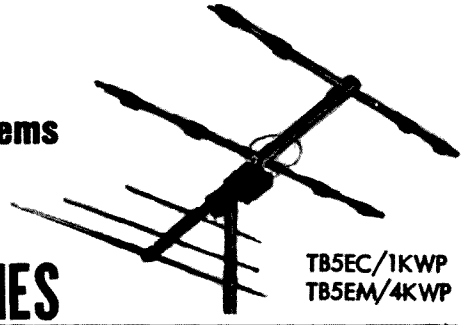
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$15.95	2M6C	6 ELEMENT ARRAY	14 DB	23 DB	42°	300 W	1" x 9'	3 Lbs.	3'-6"	5'-6"	21 Lbs.	.73 Sq.Ft.	100 MPH
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$31.50	6M5C	5 ELEMENT ARRAY	13 DB	24 DB	51°	400 W	1.5"x16'	11 Lbs.	10'	9'-6"	47 Lbs.	1.70 Sq.Ft.	100 MPH
$41.50	6M6C	6 ELEMENT ARRAY	15 DB	24 DB	42°	400 W	1.5"x24'	17 Lbs.	10'	14'-0	67 Lbs.	2.29 Sq.Ft.	100 MPH
$15.95	OD-6M	"Rocket" Vertical Dipole	1.5 DB	360° Omni-Dir.		1KWP							
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$95.00	10M512C	5 ELEMENT ARRAY	12.5 DB	25 DB	48°	4 KWP	2.50 x 2"x28'	75 Lbs.	37'-0	24'	110 Lbs.		
$19.95	OD-10M	"Rocket" Vertical Dipole	1.5 DB	360° Omni-Dir.		2KWP							
15 METER CHALLENGER SERIES													
$64.95	15M312C	3 ELEMENT ARRAY	8.9 DB	24 DB	60°	1.0 KWP	2" x 12'	32 Lbs.	23'-6"	14'-6"	171 Lbs.	5.52 Sq.Ft.	110 MPH
$25.95	OD-15M	"Rocket" Vertical Dipole	1.5 DB	360° Omni-Dir.		3KWP							
20 METER CHALLENGER SERIES													
$139.95	20M316C	3 ELEMENT ROTARY	8 DB	28DB	55°	4 KWP	2.50,x2"x16'	32 Lbs.	36'	22'-0	188 Lbs.	6.02 Sq.Ft.	110 MPH
$194.00	20M428C	4 ELEMENT ROTARY	10 DB	28DB	58°	5 KWP	2.50,x2"x28'	70 Lbs.	36'				
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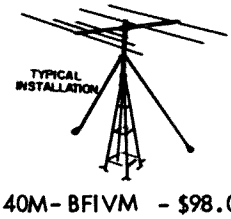
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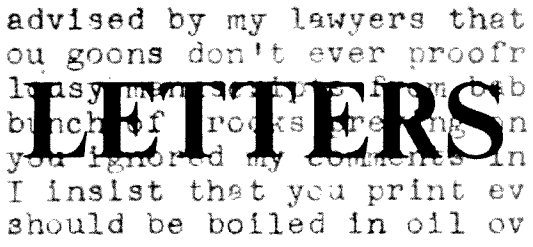
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Crystal Plea

I am a prospective Grade II (5 wpm) ham (expecting my license). Maximum power allowed is 25 watts in the 14000 to 14350 kHz amateur band. In our country, ham equipment is not available for sale. However, I have managed to procure one junk Hallicrafters SX-28 which is in working condition. I hope I shall be able to rig up a 25 watt transmitter using two EL84s (6V6) as final amplifiers. But, a stable vfo will be prohibitively expensive for me to assemble, and crystals are just not available. I understand that war surplus crystals are available at a nominal price in the U.S. Kindly help me to locate a ham who is willing to send me a few war surplus crystals. It will be convenient if the crystals are of the type that can be plugged into standard octal sockets and the frequencies are in the range of 7000 to 7100 kHz so that I shall be able to operate in other bands (14000 to 14350, 21000 to 21450, and 28000 to 28700) by frequency multiplication when I am qualified for Grade I (12 wpm).

Mathews Pulican
13-E. Govt. Quarters
Santa Ines, Panaji P.O.
Goa. (India)

Decision

Please enter my subscription to 73 for 3 years at $12. After comparing your publication to three other amateur radio magazines the choice was an easy one to make.

Richard H. Smith WQ9IAQ
Lot 403
2130 Miller Trunk Highway
Duluth MN 55811

Maltese Directory

I am a Maltese ham living in Canada for the last 20 years, I still have an active 9H1AW call, also a G3WJL active call. During the last few months a number of Maltese hams from England, Canada, U.S.A. and Australia have asked me to create a book of as many Maltese hams as I can find; therefore I wish to say "Any Maltese emigrant to any country in the world who holds an amateur license) please write to; George N. Muscat.

G. N. Muscat VE3GNM
3913 Casgrain Drive
Windsor 22, Ontario, Canada

CB vs Hams

As a county Civil Defense director, I work with both groups and from where I sit there is no conflict involved. I have been involved with a number of emergency situations using both services and have found both groups, in a pinch, willing to do anything they possibly can to help.

First, there are just not enough hams, particularly those with mobile equipment to make much of a dent in the crying need in an emergency. As an example, in this county of roughly 25,000 souls, we have about a dozen licensed hams, most of whom are inactive. Back in the late 50s and early 60s we bought a dozen Gonset Communicators and issued them to the members of local clubs. This was about the same time that CB made its debut. Since that time interest in ham radio has lagged, and CB use has increased. At the present time there are a half a dozen 6m Communicators stacked in my office available to any local hams who will keep them operable. Most of those who presently have them do not have mobile antennas on their cars and probably would have to look around for anything more than a piece of loose wire to cut to length (after digging up an outdated handbook for the proper dimensions).

On the other hand, we have something in the neighborhood of a hundred CB operators, many of these with mobile units. I might add that I'm referring to solid citizen type of CB users rather than the irresponsible type commonly equated with CB.

On a number of occasions, I have found CB an answer to a highway accident I have been involved with personally or in obtaining aid for someone else. Ham radio would have been out of the question because the coverage just *was not there*. In one case, a life was saved because there was someone on the air to take a call. Ham radio facilities were nonexistent and CB was the only available answer.

After the close of WWII, ham radio made some great steps and enthusiasm was at an all-time high. Now, with incentive licensing and other factors that contrast with CB, ham radio does not have the glamor it formerly had and the interest is lagging.

My personal feeling is that an updating of the ham radio licensing structure in line with the state of the art and the civil rights laws just to mention a few of the many.

Bob Forman W9RJH/K9TNX
P.O. Box 68
Monmouth IL 61462

April

Just received issue #115 (April) and all I can say is WOW. A very fine job indeed. I see works like this and become even *prouder* of being a part of it all.

Jack Forbing K9LSB
1416 Lakewood Drive
Fort Wayne IN 46809

April Cover

It was quite a surprise to see our building and television towers on the cover of my April 73. The Sandia Television Corporation operates this building. We arranged to allow WA5JDZ to install a repeater in the building and operate there free – including power.

Television stations KOB and KGGM-TV share this facility, as you might guess by the two TV antennas shown. The two domes are microwave dishes for a cable feed down south to Roswell. The little white house in the middle is a weather station which the personnel maintain for the weather bureau – the highest weather station

RG 196 AU 50 ohm teflon coaxial cable. Outside diameter .080" RF loss .29 db per foot at 400 Mhz. Silver plated shielding and conductor. Used for internal chassis wiring, antenna coupling, RF coupling between stages, etc. Random lengths from 35 foot to 150 foot. Colors: black, red, brown, blue, gray, orange. Regular price- 23¢ per foot. Our price 5¢ per foot $3.00 per 100 ft.
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T-3 Has a powdered iron core and is built like a TV fly back transformer. Operates at about 800 CPS. 12V DC Pri. using 2N442's or equivalent. DC output of V/DBLR 475 volts 90 watts. C/T feed back winding for 2N442's. $2.95 ea. -2 for $5.00

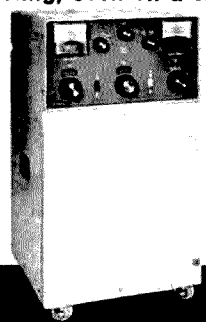
TRANSFORMERS

P-7 117 VAC Pri. Sec. #1 185 VAC @ 120 ma. Sec. #2 6.3 VAC @ 4A. Double Half Shell Mail Box Type. SX 146 type. $2.75 ea. -2 for $5.00
P-9 117 VAC Pri. Sec. # 900 VAC @ 300 ma. Sec. # 2 100 VAC @ 10 ma. Bias. Sec. #3 12.6 VAC @ AMP. Wt. 16½ lbs. Double Half Shell $4.50
P-10 117 VAC Pri. Sec. #1 960 VAC C.T. @ 160 ma. Sec. #2 425 VAC C.T. and tap at 100 VAC 10 ma Bias. Sec. #3 12.6 VAC @ 4.5A Double Shell Mail Box type. Wt. 8¾ lbs. $3.75
Output transformers, all types 59 cents or 3 for $1.50
OT-1 Transistor TO-3 Power Diamond.. Imp. 15 ohms to 3.2 ohms DC Res. Pri. .6ohm. Sec. .3 ohm.
OT-2 Pri. imp. 7000 ohm. Sec. 3.2 and 500 ohm for Phones or 70 volt line 3 watts. Full shielded Double Half Shell.
OT-3 Pri. imp. 5500 ohms. Sec. 3.2 ohms. SC122 type.

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with daily reports in the U.S. The Public Service Company has a meter-reading microwave link, too. It's quite an elaborate electronic installation.

I use 73 for ideas adaptable to our business. Currently, we are very interested in 900 MHz equipment adaptable to UHF television translators.

George S. Johnson
Sandia Television Corporation (NSL)
P.O. Box 1351
Albuquerque NM

Burn Baby Burn

Surpressing a great desire to "keep my mouth shut," I would like to express my viewpoint about a few remarks made in the February and April issue of "73," concerning the Technician class licensee by Dave Mann and Wayne Green. I take no particular personal exception to the remarks of "73" as I am not a Technician and because I believe that such articles are in keeping with the basic philosophy of "73," i.e. that everything printed in "73" may not be "gospel," but that if enough readers' minds are stimulated and challenged, some solutions and "truths" may emerge.

Basically, I agree with Misters Green and Mann that some change is necessary. I do, however, feel that Dave Mann and Wayne Green may have gotten a little carried away in trying to show cause. The examples given to prove the Technician class licensee as unworthy of the distinction of amateur, apply to every class of license. To lack character and integrity is not only a weakness found in SOME Technicians, but in SOME General, Advanced, and Extra class licensees. To imply that a Technician gets his license by cheating is not only irresponsible journalism but is lacking in good sense.

It would be well to note that those Technicians, Novices, and Conditional class licensees who gained their ticket by cheating did so with the knowledge and consent of some higher (?) class licensee. And, oh yes, the higher class licensee, in the spirit of our fraternity, took nothing (much) for this service. Perhaps, we who saw practices like this and did nothing are just as guilty as those involved.

I certainly hope that the Technician or Novice that tunes in on the General, Advanced, or Extra bands, doesn't judge all of us by the occasional "lid" or loudmouth that gets on. If a problem exists and that problem deals with infractions of the law, then enforce the law. If a program is a failure or not relevant any longer, then *replace* it with a better program. Don't spend time running down a fellow because he doesn't have as high a grade license as you or because he took advantage of a program authorized by the government even though it may not be your "bag." The same, I might add, applies to the CB'er.

This "higher than thou" attitude reminds me of a club 18 years ago that no longer exists. The club's attitude was if a fellow wasn't at least a General, he wasn't anything. And, of course, we had that asinine philosophy of "well, if I did it, he can do it" to put up with. I need not go into detail to describe why the club died.

As for Technicians operating on 10 meters, the only time 90% of us "high" class amateurs get on is when the band is open. I, for one, would certainly like to see some regular activity on this band, CW or phone.

As for the "before the examiner" jitters, I can recall when I got my General ticket the FCC examiner refused to allow a blind fellow to use a typewriter for the exam. He made him "write" it. The examiner then "flunked" him because he couldn't read the writing. I also recall a friend of mine who had gone with me to take that test. He was so nervous that he could hardly hold on to his pencil. In both cases, both were qualified but for different reasons unable to perform before Big Brother. Fortunately for the Technician license, they were part of the amateur fraternity until each made the General. This was reason enough for the Technician license.

Attitudes as expressed by 73 concerning this particular topic do not in my mind reflect the best interests of amateur radio if we are to believe what we read elsewhere in 73. We have more than enough groups to go around. We are divided enough. We need to be pulling ourselves together if we have any hope of preserving amateur radio.

73 makes with a lot of noise while ARRL has its head in the sand and CQ wanders aimlessly denying everything. Well, pass the fiddle around and "burn, baby, burn."

Rev. Peter Gonos K6GZN
1803 Second Street
Concord CA 94520

There is one big difference: At 73, we really care. The big noise is because we're concerned. A head in the sand is protection for the head, of course (which is almost useless without a body); and we don't need to tell you that aimless wandering doth not bring forth fruit. Ah, but a big noise. . .that's something else again. You, good Reverend, have written a letter; is that not a start?

. . . Ken

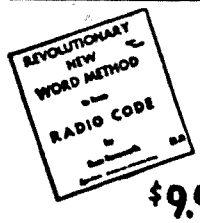
Anti-ARRL Editorials

Ken stated in his editorial, "It doesn't take a genius to figure out that if every dissatisfied ham dropped his membership, the ARRL would either change or drop out itself. Your most powerful voice is not your ARRL membership; rather it is the abscense of it." Following this reasoning it follows that if you don't like the way the country is run, the thing to do is denounce everything it does and disregard what it says. If you agree with this reasoning there is nothing wrong with the League, rather there is something wrong with K6MVH/1.

Concerning hams who don't believe (belong to?) in the League. The FCC welcomes comments from the hams (no discrimination against non-Leaguers) before it takes action on its dockets or rulings. Thus, all amateurs have a voice on issues that affect all amateurs; all they have to do is use it.

Rather than denounce the League while offering no real solution why don't you have a proposal printed in your magazine which could be sent to you to give basis to your editorials and then forwarded to the League for their consideration. Or doesn't due process appeal to you? I think 73 would have more constructive influence if it presented all the facts on specific issues with which you disagree and then urge your readers to write to ARRL expressing their ideas on the subject. I think that the ARRL reads all the mail

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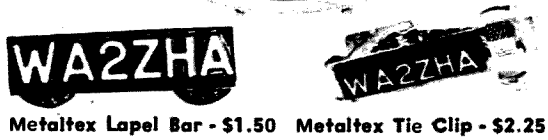
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it receives without concern to whether or not it was sent by a member. Doesn't that seem reasonable.

James M. Szot WB2VVZ
423 Lord Street
Dunkirk NY 14048

It certainly does seem reasonable. But have you any particular reason for believing the ARRL reads all the mail it receives without concern to whether or not it was sent by a member? I have proof positive, in case after case, that this is simply not the way it really is.

And why do you equate the League with the Country. I am a citizen of the Country, as is every individual born here. But I am not a member of the League, and to become one, I must pay the money. Would it not seem more reasonable to equate the League with a church? The League is but one denomination of a possible number of denominations. Yet, the League has the power to influence rulemaking for all people, be they members of that denomination or not. To me, it is like the Catholics having power to impose laws about not eating meat on Friday.

. . . Ken.

Newsbeat

I like the *"Amateur Radio News Page"* at the front of your magazine – very clever – keep it up.

Kelly W2ICE

Sour Grapes

At the risk of offending my successor as editor of this illustrious magazine, I am appalled at the lack of checking in the lead article in the April issue. It does not have the quality of an April Fool article, but it sure fools me.

The text refers to D1, D2, and D3. There are indeed three diodes on the schematic, but they are not marked.

The first i-f transformer is not identified. What is it?

The text says it is absolutely necessary to retain the exact value of resistors and capacitors, but the values are not given.

The text, under adjustment and operation, refers to adjusting voltage at point A. Where is this point ("A")?

I could go on and on. . .but I'll let you reread the article and check the schematic. When there was only one name on the masthead other than the publisher, we had a few complaints about errors. Now the masthead is full, and there should be someone about the premises who could compare the text with the diagram and make some sense of an article.

The title of the article, "A Noise Blanker that Works," is only true if you can give the reader the important details to make it work.

Kayla Hale W1EMV
Box 548
Port Salerno FL 33492

Let's face it. . . I'm incompittant.

. . . Ken.

Kickback

I am compelled to voice my sincere appreciation for Bob Manning K1YSD and his writings

in opposition to the critical letter from Jim Wagner in your April issue.

In today's world of canned media, Bob's original talent and sharp cracks at amateur radio's nuttier characters remains as one of the few sources of a really good laugh. I have just reread "Vidiots That Have Known Me," and have received just as much pleasure from it as upon the first reading. I hate to think that anyone would wish to have all humor removed from the pages of 73.

Manning's style of language is not vulgar, but reflective of true life and effectively hilarious. His "caliber of thought" is the highest kind of satire and wit, on a level that perhaps eludes some of his critics. No doubt Mr. Wagner was so shocked and repulsed by Bob's article that he felt compelled to read every word.

I know that the editor will not succumb to the "one in every crowd," and I only hope that Bob Manning will continue his contributions to this magazine that is enjoyed by so many.

Jerry "Ron" Johnson WA5RON
224 Roberts Hall
Austin TX 78705

Reference the "Letters" column in the April 1970 issue. Specifically a letter titled "Ban the Book" by Jim Wagner, taking issue with an article by Robert Manning K1YSD.

Mr. Wagner feels that K1YSD's articles are out of place in your magazine. I disagree. K1YSD's articles fit your magazine to a tee.

Let's not have fewer articles by K1YSD, but rather, more of these interesting and highly educational (?) pieces. He's the best thing you've got going for you – except perhaps Mr. Green's comments on the condition of the universe, et al. Both writers are highly amusing, though I must admit I do laugh more at Manning's stuff than I do at Green's – still they're both good.

Stan Poland WB0ABE
307 N. Logan
Olathe KS.

Ban the book? Ban the book? Ban the book?
How about "Can the Crank"?
Let's have more "vulgar" and "low thought."
Let's run K1YSD for President of folly, fantasy, and fun down with Jim Wagner.

Cal Emerson
16 Greene St.
Salem MA

73 on the March

I would like to commend someone for the most imaginative magazine cover I can recall for some time, if not all time. i.e. March 70. I enjoyed that almost as much as the contents, and that is a broad statement.

Dan Wilhite
Argenta Lumber Company
North Little Rock AR

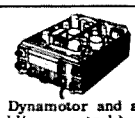
Just got and read the March Surplus issue. Wonderful. Best value for the money is your magazine. Kyle's article on surplus logic is priceless. I've been looking for down-to-earth info like this for a long time. Now – if someone will just tell me how I can tell if an unmarked diode is or is not a Zener!

John G. Pere WA8YIM
2143 Pressler RoadAkron OH 44312

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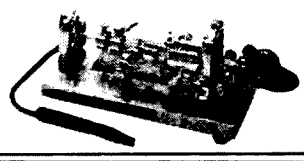
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the only time I came to grief on this was with those Italians and the U.S. stations. I knew the U.S. operators understood English, so the only explanation for their behavior was that they just didn't care one bit what I or anyone else thought of them. I made only a small fraction of the U.S. contacts that I might have otherwise. Oh, I tried splitting frequencies, and this worked at some times. The best results to the U.S. were when conditions were marginal and only a few stations were coming through. When the band was wide open with hundreds of stations wanting to get through they were not about to work with any system whatever – prefixes, lists, or anything else.

You know it only takes about two persistent stations to absolutely ruin a good band opening like that. One station in Brooklyn flatly refused to permit me to work from a list and he called in constantly every time I tried to stand by for anyone. I was so busy trying to hear through him that I neglected to write down his call ... too bad ... I sure would like to let that louse know what I think of him and how many dozens of stations he prevented from working JY1.

Even so, I contacted hundreds upon hundreds of U.S. stations, and as I said earlier, I doubt if anyone that seriously needed JY1 missed it.

I even had the surprising experience of being snubbed. I heard VQ9CD calling CQ U.S. from Chagos so I broke in and called him ... he absolutely refused to answer me!

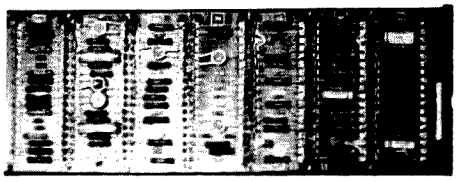
Though I didn't stop to count, I am sure that JY1 is well over the 100-country mark. Every now and then a rare one would call in through the pileups.

The original aim of getting JY1 well worked so His Majesty could sit back and enjoy hamming was achieved, I think. Although I am not so sure that this is of as great importance now as it was when I arrived. His Majesty sat for hours watching me operate, and spelled me when a particularly obdurate Italian would wear me down a bit. During the all-night stint His Majesty sat there right up until we closed down at 7 a.m.! And he enjoyed every minute of it. As my time for departing came closer I noticed that he was getting to be able to handle pileups very well ... and enjoying them!

After two weeks of almost daily contact with His Majesty it is hard to think of him as a King ... he is a friend. When you run into him on the air please be considerate so we can keep him a friend of our hobby. You just might go out of your way a little when you hear him operating to watch over him and protect him from the inconsiderate.

At the request of His Majesty I outlined a set of amateur radio regulations that are custom-made for Jordan. The Royal Jordanian Amateur Radio Society is in the process of being established with His Majesty as honorary president and Mrs. Salti as the secretary. My proposal calls for

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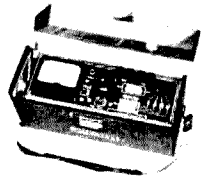
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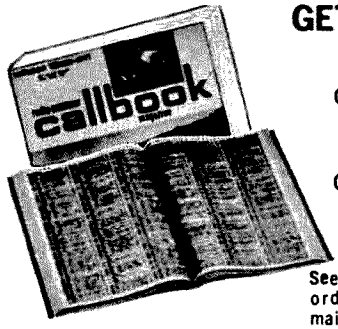
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two classes of license for Jordanians, a Class B and a Class A. Both would require five words per minute code speed, with the Class B permitting restricted power operating in the CW bands on 80-40-15-10, plus phone on the VHFs. The B license would be similar to our Novice in difficulty and the A would be more like our General.

I also proposed a special visitors license good for ten days and a license for aliens resident in Jordan, both requiring valid home amateur licenses.

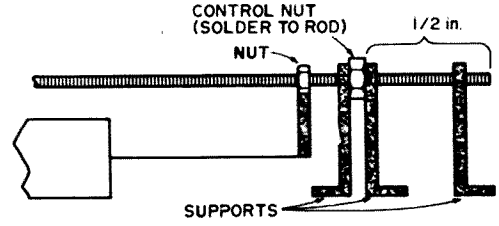
There seems to be good reason to believe that these beginnings will bear fruit. I outlined the plan to an assembly of the General of the Army, the General of the Air Force, the head of the Royal Auto Club (I also wrote in permission for mobile operation), the Minister of Communications and other dignitaries. One or two shuffled their feet and wanted time to study the matter and think about it, but His Majesty urged speed, and His Majesty is His Majesty and what he wants happens.

For those of you who have the opportunity to contact Hussein (as he calls himself), you might keep in mind that he is an ardent flyer, has quite a bunch of cups for racing and hill climbing in his Porsches, enjoys skin diving, skiing, water skiing, and you name it. If you have nothing to talk about with him it is your lack of interests, not his. Let me also clue you that a person with a wide range of interests like that will be interested in your field of expertise, whatever it is.

. . . W2NSD ■

More Accuracy on Microwaves

There are undoubtedly a few readers who would like to construct the microwavemeter that appeared in the December issue of 73. With a slight amount of exterior modification greater accuracy can be obtained, as well as some protection against bent plunger fingers.



The modification consists of adding a thumbscrew drive for slower, smoother tuning. First, solder the plunger rods to a brass plate. To this solder a vertical support topped off with a hex net; 4-40 or 6-32 is all right. Fashion three supports with holes high enough to pass a threaded rod parallel to the base. Solder a hex nut to a 4 in. threaded rod as shown. Thread it through the plunger nut, then align the supports and fasten them to the base. Attach the pointer as per the article. Pull the plunger out as far as possible before attaching the threaded rod. Be sure that the two supports near the control nut are as close together as possible to prevent any horizontal movement of the control rod.

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(continued from page 19)

rough going since all the problems of a couple of years ago, and there's nothing like a Gus Browning outing to reawaken the too-long dormant DX bug.

One of the problems which has resulted from the division of our bands into segments is the apparent ignorance of some foreign DX operators with respect to the allocations. Many of these stations have been heard working W/K contacts in the Extra Class/Advanced frequency segments, and the General Class DX'ers have been forced to wait endlessly with their tongues hanging out. I actually heard a DXpedition recently, calling CQ for contacts, and he announced that he was listening 14.210 to 14.225. He had virtually no takers, yet there were dozens of fellows calling above 14.275, whom he didn't even know were calling him.

If the available DX is to be the sole province of the higher class licensees, and if the Generals are not going to be considered by expeditions as worthy of contacts, then the restructuring is even more diabolical than it first appeared to be.

It is one thing to establish restrictions under the principle that incentives will tend to provide impetus for individual achievement. But it is quite another thing to fail, after this restructuring, to advise all foreign hams, through their official organizations, whether affiliated in some confederation or not, that the change has been made. It is only in this way that these operations will be split up so as to afford an even break to those who can no longer operate on the low ends of the bands.

If this situation is permitted to deteriorate any further it is likely that those Generals who do not upgrade to Advanced will be forced out of the hobby altogether. It is no fun to be isolated from all others, and to be ostracized in this fashion. . .it is reminiscent of a sort of solitary confinement. And it does have the end effect of a kind of punitive punishment as the price of failure to upgrade. I'm sure that the FCC had no such intention when it imposed the new allocations. But, as the old saying goes, ". . .the road to Hell is paved with good intentions."

. . . K2AGZ ■

73 Readers' DOUBLE BONUS

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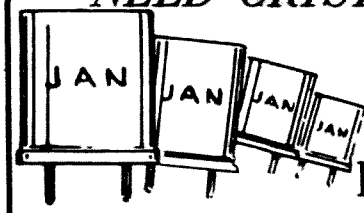
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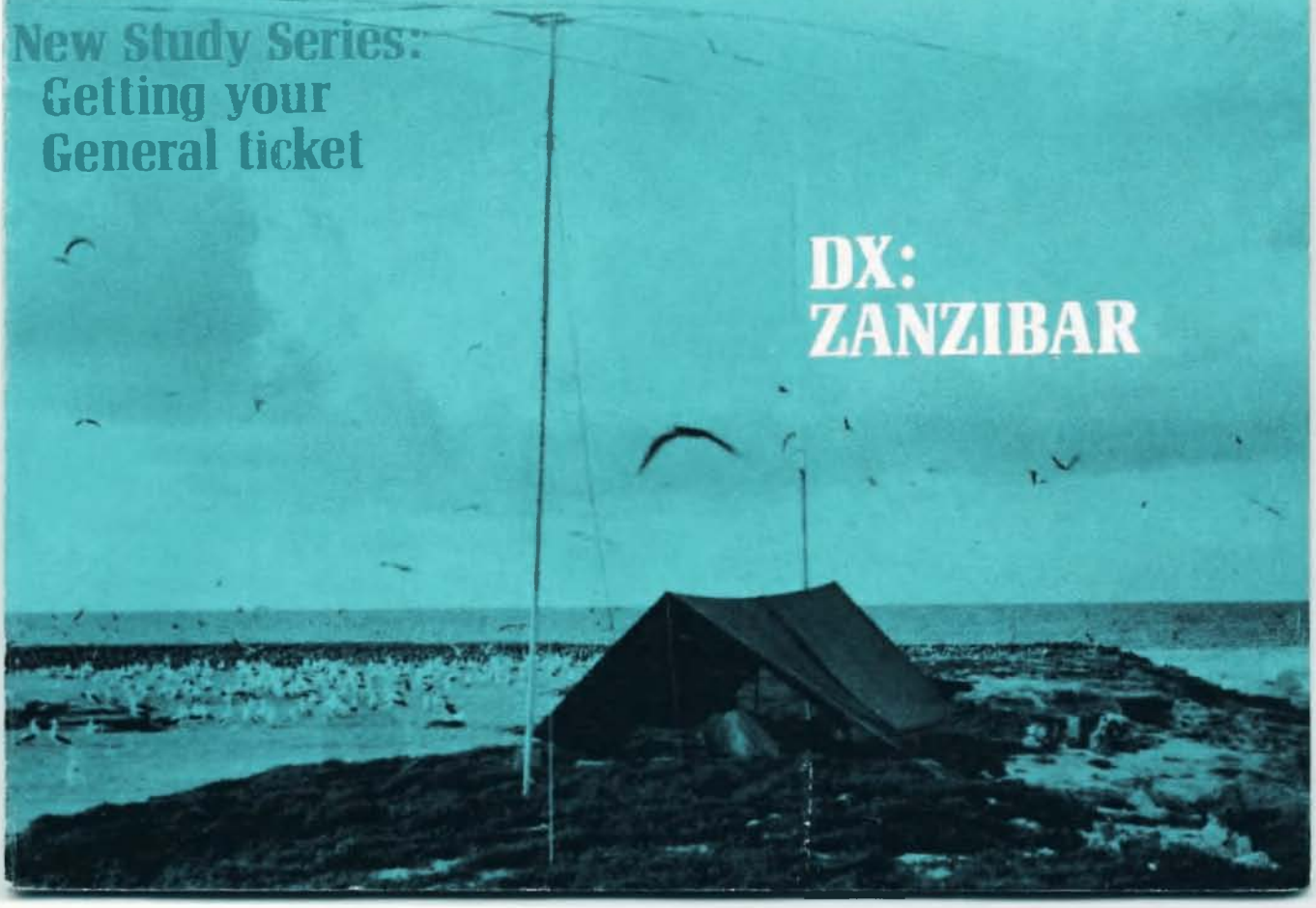
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#118 July, 1970

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Amateur Radio News Page

July XIXLXX | Monthly Ham News of the World | 73 Magazine

NO-CODE HAM "HOBBY" LICENSE PROPOSED

Washington, DC. A brand new class of amateur license – to be designated "Hobby" class – has been proposed for the central portion of the 220 MHz amateur band. This new ticket would require no theory and no code, but would involve an exam, administered by any General, covering FCC rules and regulations governing operation in the applicable spectrum.

FM Only

The Hobby license would permit the holder to operate with a power of up to 100 watts using narrowband FM (±5 kHz deviation) in the frequency range from 220.5 to 224.5 MHz. This license would be available for a fee of $5 for a five year period and would be renewable upon proof of use and a $5 fee. The 220.0–220.5 and 224.5–225.0 MHz segments of the band would still be open to higher classes of license as presently authorized, thus preserving one MHz of the band for exclusive use of the higher classes of license.

The use of FM techniques would eliminate the problems of heterodynes which contribute so much to the frustrations of the 27 MHz band and would provide simple network systems with squelch as is now popular on the 144 MHz band. Though tion would be within the 450 MHz amateur band and would also be unlikely to interfere with commercial bands. A 500 kHz "guard" band for higher class amateurs on each side of the proposed Hobby band would provide adequate isolation for errant operators to keep them from interfering with adjacent commercial bands.

Callsigns

In order to indicate the class of license by the call letters, a new set of callsigns would be established for the Hobby license using the regular amateur call areas, but starting with NA1AAA and going through to NZ1ZZZ, a system which would provide for over 4,500,000 callsigns to be issued. When a Hobby operator goes to a higher class of license the last three letters could be passed along to the WA1AAA type of call letter, thus preserving the identity of the operator through this counterpart call.

Something for Everyone

The Hobby license would seem to fulfill a number of needs without taking anything away from anyone. It would provide a legal hobby band which is obviously needed. It would help the Commission solve the problems of the citizens band. It would

Seven Club Stations for Jordan

King Hussein has ordered seven complete amateur radio stations for installation in Jordan schools, orphanages, and remote military bases. Each of these stations will run a full kilowatt into a three-band beam and should put out substantial signals.

The King, recognizing the importance of amateur radio to the development of Jordan, has authorized an amateur radio service for the country and a drive is on to attract people into the hobby. Equipment is difficult, if not impossible, to get in Jordan, so the seven club stations should provide a means for the first amateurs to get on the air and develop their skills.

The activity of these club stations should remove Jordan, once and for all, from the ranks of the rare countries. The first amateur license in Jordan is a CW-only ticket, which means that most of the early operation of these stations will probably be on that mode.

One of the club stations will be installed at a remote air base. It will be used by air force personnel who have passed their amateur license exams. The men at this base are far from any town or any other means of communications, so we should hear quite a bit from them on the ham bands.

Arrangements are being made for the operation of some of the club stations by visitors to Jordan, thus making it unnecessary for tourists to bring their own equipment in order to operate from this rare country. The 220V 50 Hz line power that is standard there would make it particularly difficult to use the U.S. ham gear and the wide variations in line-voltage equalizing equipment to protect the rigs.

Tourists visiting Jordan will be issued special calls starting with JYØ, while the Jordanian operators will have JY7 and lower numbers. Only the King will have a JY1 call.

King Hussein surprised the amateur fraternity by turning up on the ham bands early this year using a Drake station bought for him by his wife as a Christmas present. The station was installed at his home (Hummar) just outside of the capital city of Amman with the help of SVØWI, who came over from Athens. The King chose the call JY1 for his station and, as a result of many years of no amateur operations from Jordan, had his hands full at first giving the thousands of DX'ers

crystal control would not be required, it would probably be extensively used as it is for 144 MHz FM operations.

This Hobby license would provide a band where hobby operation is legal, and would thus free the 27 MHz band for business use as originally proposed by the Commission. The large number of channels available in the 220 MHz band would provide relatively interferend provide relatively intereference-free communications for the operators, offering them adequate reasons for changing from the 23 channels on 27 MHz. The coming dropoff in skip conditions on 27 MHz will work to the end of encouraging the changeover. This band, as with all other amateur bands, would be largely self-policing, thus removing a very expensive headache from the Commission.

Repeaters

The Hobby license would permit communication through repeaters, but a higher class license would be required for the installation and maintenance of a repeater, since technical knowledge is much more necessary for the installation than the use of a repeater.

The amateur 220 MHz band is above television channel 13, so interference to television reception would be unlikely. Second-harmonic radiation would not be a problem. The Hobby license would provide activity on a virtually unused amateur band. It would encourage an influx of new amateurs. It would provide millions of dollars in fees to offset Commission expenses with little overhead involved, since all of the examinations would be given by volunteer radio amateurs. It would encourage the development of commercial narrowband FM equipment for the VHF bands which would benefit all amateurs as well as users of adjacent commercial bands. It would encourage the development of fixed-station equipment, mobile equipment, portable equipment and hand-held equipment, autotuning receivers, autocall signalling equipment, etc. It would also give a number of manufacturers a very bright future.

1300-PLUS ATTEND N.Y. HAMFEST

Despite threats of rain, over 1300 amateurs gathered for the yearly Western New York Hamfest just outside of Rochester, New York on Saturday, May 16. The biggest drawing card of the hamfest was the acre or so of flea market. . .dozens of cars and trucks loaded to the hilt with equipment and parts. . .driving otherwise normal hams right out of their minds with bargains. One hundred capacitors for $1.50. . .vacuum capacitors for that 10 kW final for $3 ($5 if you want it motor-operated), and so forth. A lot of very valuable equipment (and some beautiful boat anchors) changed hands . . .all tax-free.

Inside the hamfest building the committee kept things humming with a steady stream of interesting talks, mostly VHF-oriented. The three ham magazines had booths set up and vied with each other for subscriptions and deals. QST was the only magazine absent. (The ARRL consistently refuses to support this valuable hamfest activity.)

The skies held dry for most of the day, and then late in the afternoon they tipped the heavenly bucket and down it came, folding the flea market and sending everyone into the building to finish off the last of the refreshments and jam the technical sessions.

Wayne Green was honored at a prehamfest meeting the night before where he presented the first showing of his slides of his recent JY1 trip, including photos of King Hussein operating his station in Amman, Jordan.



Wide-angle view of the Rochester Hamfest's flea market.

a new country. For the first few weeks he had to explain to virtually every contact about his unusual call. He never said it, but the answer that was intimated was, "Why not? . . .it is the King's station." Even the ITU agreed that they would go along on that basis, though the ITU regulations do call for some sort of suffix under other circumstances.

Delivery of the club stations is expected some time in July and they should be set up and in operation in short order after delivery.

Hy-Gain BUYS GALAXY

Hy-Gain Electronics Corp. announces that it is acquiring Galaxy Electronics as the result of stock trading within the two companies. As most amateurs know, Galaxy is a leading American produce of SSB and VHF FM transceivers. Hy-Gain has specialized in the manufacture of antennas and antenna systems for amateur, CB, industrial, and military applications.

According to Hy-Gain spokesmen, the shift in management will not affect existing Galaxy warranties or service policies. Also, no immediate changes in company personnel "are presently contemplated."

The major difference that should be noticeable to hams will be Hy-Gain's shift to a "systems approach" to the communications field, whereby the company will market "complete packages" for two-way radio use.

LONG RANGE PROPAGATION NEWS

by J. H. Nelson

We will soon be entering the unsatisfactory part of the SUNSPOT CYCLE which runs from about one year after maximum to about one year before the coming minimum. The highest monthly sunspot number reached this past cycle was 135.8 which was in March 1969. The coming low is expected to arrive in 1974 or 1975.

Experience has shown these periods to be unsatisfactory during the past three cycles particularly during winter evenings and nights and during the sunrise/sunset hours. However, conditions during the summer months are quite good during this period if the proper frequencies are used.

There appears to be general agreement among the people who predict sunspot high periods that the next high period which should come around 1979 or 1980 will be below normal by a significant amount. I have done some research on this subject myself using both their methods and my own long-range forecasting technique. My conclusions are similar. This can cause a significant reduction in the number of useful hours for 10 meters during the next high sunspot period.

British Steam Train Will Use U.S. Hams

This summer the British train *Royal Scotsman* will be touring the western portion of the United States advertising British-made products and giving the Americans a chance to see this famous steam-powered train. The Hallicrafters Company has decided to equip an amateur radio station on

Designation of Bands

The FCC says it is receiving inquiries concerning the exact meaning of various letters sometimes used to designate the limits of a number of frequency bands, largely in the microwave region of the spectrum. The use of these letter designators, such as L, S, and X, was initiated during World War II, primarily for security reasons. However, they still occasionally appear in electronic publications, both in technical articles and in advertisements, and are sometimes used in offices of some Government agencies. Largely, their use is confined to documentation dealing with radar, telemetry, and electronic countermeasures equipment.

A number of letter designator systems have appeared over the years and their use continues to generate confusion because of the lack of standardization, nationally or internationally. Difficulties arise because, in some instances, the band limits vary from one system to another, and none can be considered authoritative. Because of this, the FCC discourages the use of single-letter designations and says that it cannot answer questions regarding their meaning. Inquiries concerning them should be addressed to the source originating the information.

In the interest of avoiding confusion in this area, the frequency management interests in this country have for some years held the position that specific frequency bands should be cited in terms of their actual numerical frequency limits and have encouraged the public to do the same. For example, the U.S. FM broadcasting band is designated 88–108 MHz in our Table of Frequency Allocations, which precisely defines the band in terms well understood in the engineering and scientific community. In that connec-

ACTION IN DOCKET CASE

FCC's regulation of rf devices extended to sale, shipping, and advertising effective October 1, 1970; to implement 1968 law, reduce radio interference.

Manufacturers, vendors, and shippers of radio frequency devices that emit electromagnetic energy capable of causing harmful interference to radio communications must meet the technical standards of FCC rules after October 1, 1970. The new order implements a 1968 law empowering the Commission to make reasonable regulations governing the interference potential of certain devices. (Section 302, "Devices Which Interfere with Radio Reception," was added to the Communications Act on July 5, 1968, by Public Law 90-379, 82 Stat. 290.)

The Commission said that the purpose of the new rules is to require compliance with equipment standards by manufacturers, importers, and distributors of rf devices, as well as by users, and that the rules apply to many persons and companies not now directly subject to regulation.

The revised rules prohibit the sale, transfer, importation, shipment, or distribution of rf-generating devices unless the devices meet the Comnission's technical standards or have been type-approved, type-accepted, or certified. (Type approval is based on testing by the Commission; type acceptance and certification on testing by the manufacturer, his notification to the Commission, and the Commission's acceptance of the test results.) The Commission said that it is presently reviewing its regulations to determine what changes are necessary in its type approval, type acceptance, and certifi-

News, Reviews, Announcements

Free Award

A new award is being issued free to anyone who has worked all 17 Monroe counties in the United States. Send SASE to Max Holland, Hiwassee College, Madisonville TN 37354. No QSL cards needed to verify contacts. Just state whether contacts were on single band or all bands.

Zero-Beaters

The Zero-Beaters ARC Hamfest will be held on Sunday, August 2. Washington, Mo. City Park. For further information write or contact Zero-Beaters ARC, Box 24, Dutzow MO 63342.

MVARA Hamfest

The Mahoning Valley Amateur Radio Association will sponsor a hamfest Sunday, August 2 at Lions Park, New Bedford, Pa., located nine miles east of Youngstown, Ohio, one-half mile north of Hwy 422 on Rte. 932. Door prizes and flea market. Call-in freq. 146.94 and .34–.76 repeater. For information contact Frank Dodd K8UYF.

Glacier-Waterton

The 36th annual Glacier-Waterton International Peace Park Hamfest will take place in Glacier National Park, July 18 and 19, 1970. Amateur radio operators from Montana, Idaho, and Washington, along with good neighbors to the north – Alberta, Saskatchewan, and B.C. will gather to further a mutual interest in ham radio, and to just have fun. This is a biggie; don't miss it!

board the train, and is now in the process of lining up operators to man the station for all or part of the operating period, which will extend from June 14, 1970 until early August 1970.

A special callsign will be issued for this railroad mobile expedition and a special QSL will also be available.

A spokesman for the expedition said the train will leave Lubbock, Texas on June 14 and make its way across Texas, Oklahoma, Kansas, Missouri, and on to Chicago – then to Green Bay, Wisconsin, stopping at various cities en route. Amateur operators are needed to either ride on the train to operate the station or to help operate the station while the train is at rest in the various cities. Transportation on board the train as well as sleeping accommodations will be furnished at no cost. The spokesman said dining facilities will be available on the train. Meals will be taken at stops along the way and will be at the expense of the individual participants. Participants must furnish their own transportation to and from the location of the train.

Any licensed ham who would like to participate is invited to contact one of the persons listed below for further details as to schedules, times, dates, and places:

Archie L. Julian WB4CYR
6921 Fort Hunt Road
Alexandria VA 22307
(703-768-3412)

Jim Adams
1520 Wolfram Street
Chicago IL 60657
(312-935-1687)

Hoosier Hills

The Hoosier Hills Ham Club Hamfest will be held on October 11, 1970 at the Spring Mill State Park near Mitchell, Indiana. The main prize is to be a Drake TR-4.

tion, the number of digits required to describe bands higher in the spectrum may be reduced by using the nationally and internationally adopted term GHz which is equal to 1000 MHz.

Broader portions of the spectrum may be described by a nationally and internationally adopted series of widely used phrases, and their abbreviations, as follows:

Very low freq. (VLF)	3–30 kHz
Low frequency (LF)	30–300 kHz
Medium freq. (MF)	300–3000 kHz
High frequency HF)	3–30 MHz
Very high freq. (VHF)	30–300 MHz
Ultra high freq. (UHF)	300–3000 MHz
Super high freq. (SHF)	3–30 GHz
Extremely high freq. (EHF)	30–300 GHz

FCC Rules Amended Uniform Expiration of Licenses

A uniform expiration date for amateur operator and station licenses has been provided for by the FCC in an amendment to Section 97.59. The rules for the amateur service provide for issuance of an amateur operator license, and normally the amateur operator and station license expire on the same date. During the term of his basic license, however, should the licensee obtain an additional station license, the present rules do not show the Commission's current practice regarding the expiration date for additional amateur stations. The Commission said the amendment will reflect this practice, as shown in Item 5E (FCC Form 610), that the license of an additional station will expire on the same date as the operator license. The rule amendment became effective on May 1.

cation procedures in view of the new regulation.

Only one category of rf devices – incidental radiation devices, such as electric motors, automobile ignition systems, and neon signs – was excluded from consideration in this proceeding, the Commission stated, because technical standards governing their operation have not yet been prescribed.

Devices subject to Commission authority and included under the amended rules range from the many kinds of radio transmitters used in the broadcasting, common carrier, marine, aviation, and land mobile services to restricted radiation devices; wireless microphones; phonograph oscillators; radio-controlled garage door openers, models, and toys. Various types of industrial, scientific, and medical equipment such as ultrasonic, industrial heating, medical diathermy, radio-frequency-stabilized arc welders and miscellaneous equipment, are also subject to the new rules.

The Commission exempted the manufacture of rf devices from the new regulations, so as not to curtail research. It also exempted from the new rules transmitters operated in the AM, FM, or TV broadcast services, or in the Instructional Television Fixed Service, and certain Industrial, Scientific and Medical equipment governed by Part 18 of the rules, including industrial heaters. (Industrial heaters that generate less than 10 kW of rf are subject to the condition that the purchaser be notified in writing whether the equipment, as delivered, complies with the technical requirements of Part 18 or whether a shielded enclosure is required.)

In response to comments expressing fear of an adverse impact by the new rules on preproduction marketing of products still in the design and development stages, the Commission stated that the new rules will not "preclude the proposal or execution of agreements to manufacture or produce in the future new products in the design or development stages or products which are to be manufactured in accordance with designated specifications." Advertising for sale of existing rf devices before it has been determined that the devices meet Commission requirements is prohibited, however, the Commission said.

Michigan

The 17th Annual South Western Michigan VHF Picnic will be at the Allegan County Park, August 2, sponsored by the Van Buren County Amateur Radio Club, W8JUU, Bangor, Michigan.

Iowa

The date of the Iowa 75 meter phone net picnic has been changed from August 9 to August 16. The picnic will be held in Marshalltown, Iowa at the Riverview Park. Festivities will begin around noon with the frequency of 3970 kHz being monitored.

England

Becket Festival Station GB2CF will be active from Canterbury, England, during July 19 to 26 inclusive. This station will form part of the Becket Festival and QSOs, which will be QSL'd with a suitable card, will be most welcome.

QSOs with stations in the U.S.A. particularly in towns called Canterbury or any of the following local names of towns and villages which surround our city – would be most welcome:

Ash	Chilham	Bekesbourne
Bridge	Chartham	Faversham
Herne	Kingston	Herne Bay
Ickham	Selling	Littlebourne
Sturry	Stelling	Patrixbourne
Wye	Wingham	Wickhambreux
Aylsham		

Repeater Docket Comment Deadline Extended

As a result of requests by the ARRL and a Mr. Neil Murphy, the FCC has agreed to move the deadline for comments to Docket 18803 from May 15 to June 15.

The ARRL based its request for extension on (1) the scope and complexity of the subject matter and (2) delay in considering the proposal caused by "internal procedures." When the FCC issued its order, it did not elaborate on the meaning of the League's "internal procedures" statement.

Mr. Murphy stated that additional time was needed because of the complexity involved in "preparing a proper commentary."

The Conmission said that since the views and reply comments of interested parties might be useful in a subsequent rulemaking, additional time for comments seemed reasonable. In its order, released May 18, the FCC declared the conment deadline to be June 15, 1970, and the deadline for reply comments was rescheduled for July 7, 1970.

DELAYED LICENSES

A number of amateurs have complained that they have gotten letters from magazines seeking subscriptions or from companies hoping to sell them something, complete with their call letters on the address, before they have received their license from the FCC. Could this be? The following letter from the FCC tells us that it can be.

Acknowledging your recent letter, the Commission's Rules and the Public Information Act (P.L. 89-487) provide for the public inspection of all applications and related files in the Safety and Special Radio Services.

Several organizations make a regu-

Eighth Annual Illinois QSO Party

Starts 1600 GMT Saturday, August 1, 1970 and ends 2200 GMT Sunday, August 2, 1970. Use all bands, CW and phone. The same station may be worked and counted for a QSO point on each band and each mode. Illinois stations score 1 point per contact with stations either in or out of Illinois. Stations on county lines count only one point per QSO, the same as any other station. Stations outside Illinois score 1 point per QSO with Illinois stations. Illinois stations multiply total QSO points by the total number of states, VE provinces and ARRL countries worked. All others multiply total QSO points by the total number of different Illinois counties worked. Stations on county lines count as two or more counties. Additional bonus multipliers may be counted for working the same county. Each group of eight contacts with the same county count as an extra multiplier. (10 QSOs count as 1; 16 QSOs count as 2 multipliers, etc.) USA, Canada, Hawaii, and Alaska count as separate countries. KH6 and KL7 also count as states. Illinois stations give QSO number, RST, and county. Others give QSO number, RST, and state, province or country. Use approximately 3560, 3735, 3900, 7060, 7175, 7260, 14060, 14275, 21060, 21110, 21360, 28060, 28660 kHz and 145.2 MHz. In Illinois, single- and multiple-operator stations compete in separate categories, with certificates issued to first, second, and third place winners. Elsewhere, certificates will go to the top scorer in each state, VE province, and country provided that at least two valid entries are received from that region. Other certificates may be issued at the discretion of the contest committee. Decisions of the contest committee are final. Logs must show dates, GMT, stations worked,

New Jersey QSO Party

The Englewood Amateur Radio Association invites all amateurs to take part in the 11th New Jersey QSO party.

Rules: (1) The time of the contest is from 1900 GMT Saturday, August 15 to 0600 GMT Sunday, August 16 and from 1200 GMT to 2300 GMT on Sunday, August 16. (2) Phone and CW are considered the same contest. A station may be contacted once on each band – phone and CW are considered separate bands. New Jersey stations may work other New Jersey stations. (3) General call is "CQ New Jersey" or "CQ NJ." New Jersey stations are requested to identify themselves by signing "De NJ" on CW and "New Jersey calling" on phone. Suggested frequencies are: 1810, 3555, 3740, 3930, 7060, 7275, 14075, 14280, 21100, 21375, 28800 kHz, 50–50.5, 144–146 MHz. Suggest phone activity on the *even* hours. (4) Exchanges consist of QSO number, RST, and QTH (ARRL Section or country). N.J. stations will send county for their QTH. (5) Scoring: Out of state stations multiply number of complete contacts with New Jersey stations times the number of New Jersey counties worked (maximum of 21). New Jersey stations: W, K, VE, VO QSOs count as 1 point; DX stations count as 3 points. Multiply total number of points times the number of ARRL sections (including NNJ and SNJ – maximum of 74). KP4, KH6, KL7, KZ5 count both as 3 point DX contacts and as section multipliers. (6) Certificates will be awarded to the First place station in each N.J. county, ARRL section, and country. In addition, a second place certificate

VOX POP

Little Gleanings on 20

John ZK1AJ on Raratonga mentioned that ZK1AA has a 50 MHz beacon aimed at the states. That would be a nice one to hear. John's QSL manager is KH6GLU. SU1MA's QTH is Box 840, Cairo. JX4GN has been quite active of late, QSL to him via Norwegian Embassy, Reykjavik, Iceland. Odd also gets down on 3798 kHz. SVØWDD only active station on Crete, QSL to WQ3HUP if you contact Ray. Interesting development on Genada, a nonlicensed American has a ticket down there. I gather if you pay the fee you get your license. VP2GRN (Bob) and his wife Jeannie (VP2GNE) QSL via WQ4YHB. KJ6CD, Lew on Johnston, QSL to W6LTA. KG4AL is the only mobile in KG4.

QRP on 40

by WA8MCQ

Every Friday night at 2000 EST, the QRP net meets on 7080 kHz. Anyone with low power is welcome, of course, but so are those high-power boys who like to listen for the "flea-powered" stations.

From Chip Cohen WA1JHQ: 20m DXpeditions

TI9CF via TI2CMF
MP4QBK via K4MQG
W9FIU/KS4 via W9FIU
VKØHM (on Heard) via WA6EAM
OJØMI via OH2ER
5H3LV/A via VE3ODX
5HCKJ/A via W7ORN

DX Sidenotes

by WA1JHQ

Please note: OJØAA is a pirate! He was active for the first phone weekend

lar practice of excerpting license and application information from the Commission's records and making it available to their subscribers.

It occasionally happens that the excerpted information reaches subscribers to these services before the licensee receives his license.

James E. Barr
Chief, Safety and Special
Radio Services Bureau, FCC

Prayer Brings Astronauts Home?

The faith of the nation was strenghtened when the President asked all citizens to go to their knees in prayer for the safe return of the Astronauts. Now, hams who believe in prayer have the opportunity to be the vital connection between emergencies around the world and hundreds of praying people in their own communities.

The Wycliffe Bible Translators, a nonprofit, nonsectarian mission, has over 2000 workers in remote areas of the world translating the Bible in to tribal languages. With a team this size, there is an emergency every day – somewhere. In U.S. cities people want to know what the emergencies are so they can pray.

The Prayer Force Net has been established to communicate these emergencies. Any ham joining the net would meet one of four weekly scheds and relay the news by phone to one or more people in his community. From there a telephone net takes over.

Here is the Prayer Force Net schedule:

Tuesday	0030 Z	14.310 MHz
Friday	0030 Z	21.390 MHz
Friday (W Coast)	0330 Z	7.268 MHz
Saturday	1600 Z	21.310 MHz

If interested, simply check into the net, and other net members will help get your community organized. For info, write: Prayer Force WA6CJB, Box 2000, Santa Ana CA 92707.

exchanges sent and received, bands, modes, and claimed score. A summary sheet should be sent, showing whether single- or multi-op, name and address of operator clearly printed, QSO points, multipliers, and score. Logs must be postmarked no later than 1 September 1970, and should be mailed to the following address with adequate postage: Radio Amateur Megacycle Society, 3620 N. Oleander Ave., Chicago IL 60634.

Mayflower 70 Award

This award has been instituted by the committee governing the Cheshire Homes Amateur Radio Network Fund to commemorate the 350th Anniversary of the sailing from Plymouth the Pilgrim Fathers for America 1620. (The Homes care for the incurably ill and permanently disabled.)

The object of this award is to continue efforts to provide amateur radio equipment to the Homes. All profits from this award will be devoted to this purpose; no member of the committee will receive payment or reward for services.

The award is open to all ham operators and SWLs, and there is no time limit.

Any band or mode of transmission will be allowed; QSL cards need not be sent with claims, but a certified copy from the station logbook must be sent in with claims.

To Qualify for the Award

Operators in the U.S. must furnish proof of having had contact with one amateur station operating from Plymouth. Shortwave listeners must show verification of reception of one amateur station.

Certificates

The cost of certificates is one dollar, which includes postage by surface mail. Forward all claims to the award manager, W.M. Clarke G3VUC, Fillace Park, Horrabridge, Yelverton, Devon. PL20-7TE.

will be awarded when four or more logs are received. Novice and Technician certificates will also be awarded. (7) Logs must also show GMT date and time, band, and emission, and be received not later than September 12, 1970. The first contact for each claimed multiplier must be indicated and numbered and if possible, a check list attached. Multi-operator entires should be noted and calls of participating operators listed. Logs and comments should be sent to Englewood Amateur Radio Association, Inc., 303 Tenafly Road, Englewood, New Jersey 07631. A size 10 SASE should be included for results. (8) Stations planning active participation in New Jersey are requested to advise the EARA by August 1st of your intentions so that we may plan for full coverage from all counties.

1970 International Field Day

The Burlington Amateur Radio Club, Inc., invites you to the 1970 International Field Day to be held at the Old Lantern, Charlotte, Vermont, on Sunday, August 16. Come one day early on Saturday and join the crowd with trailer, camper, or tent. Featured will be the popular flea market, net meetings, antenna raising contest, junkbox amplifier contest, hidden transmitter hunt on 2m FM, mobile and portable rf output contest, Bingo for the ladies, door prizes, and raffle drawing. Talk-in frequencies include 3909 kHz and the .34–.94 MHz facilities of the W1KOO and W1ABI repeaters. Food, refreshments, and camping supplies available all day. Registration is $3 at the gate (or send $2.50 for early-bird to Bill Fake W1FS, 30 Southill Dr., Essex Junction, Vt.) For further information, write or call Bob Hall W1DQO, General Greene Rd., Shelburne VT 05482.

of DX competition but Eric, OH2ER, tells me he has no authorized permission to land or operate from Market Reef. Besides, OJØMR and OJØMI keep Market Reef busy.

Also note that W9FIU/KS4 at Serrana Bank were very active in the last week of February. As far as 5H3LV/ and 5HCKJ/a go they made a one day stay in Zanzibar, which should count for awards. VKØHM was put on by Hugh, WA6EAM but he wasn't on too much, probably not enough time.

TI9CF, Cocos was what many of us were waiting for.

He and all other's mentioned weren't on (as far as I know) for DX competition.

MP4QBK is another mouth watering tidbit since he was very active in mid-February from Qatar.

Wayne Green made great DXing for lots of us during his short stay in ultra-rare JY land. He operated JY1, the call of King Hussein.

Please announce a new net which meets. It is the technical discussion net meeting on 7.265 MHz and at 20:00 GMT. This net is to discuss problems with theory and rig troubles. We also discuss physical phenomena such as propagation, LDEs, etc. Net coordinator is WA1JHQ and net manager is WA1JYY.

What – No FM?

A "Ham & CB Swapfest-Picnic" is slated for Sunday, August 9, 1970, at the City Park in Levelland, Texas. Sponsored by the Northwest Texas Emergency Net and Levelland Communications Club, this is an unusual CB-Ham get-together that should prove fun for the entire family. Bring your own picnic basket. Registration begins at 9 a.m. Lunch at 1. Mobile talk-in frequency is the net frequency, 3950 kHz and channel 11 for CBers.

Publisher's Comment

Not long ago a letter came in from an irate subscriber in Europe. He complained that the magazine took a month to get to him and that it was stale by the time it arrived. This extreme sample of idiocy made me so exasperated with the human condition that I decided to try just leaving the confounded month off the cover. The material in 73 is almost all made up of articles, more like a handbook than a radio magazine, and there is little in each issue of any real time value. So what possible difference could it make to anyone whether the issues arrives in a week, a month, or two months?

Sure, we rush through articles on new developments, but most of the material could just as well be published next year or last year. This is one of the reasons that back issues of 73 have held their value so well.

Spreading the Blame

Many ex-ARRL members who have written to HQ expressing their dissatisfaction with the ARRL-sponsored incentive licensing have received replies which point out that Wayne Green W2NSD/1, editor of 73, also filed a proposal having to do with incentive licensing. This is true – I did file RM-577, but this proposal suggested rewards for obtaining the higher class licenses and did not in any way support the ARRL concept of punishing those who did not advance. RM-577 suggested the issuance of two-letter calls to Extra class licensees as an incentive, and this was accepted. It also proposed that there be separate Extra licenses for phone and CW and this was essentially enacted with the Extra phone being embodied in the reactivated Advanced class license. RM-577 proposed the opening of the following bands for SSB: 3750-3800, 14150-14200, 21.20-21.25, 28.4-28.5,

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. Include your check with order.

Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

For $1 extra we can maintain a reply box for you.

We cannot check into each advertiser, so Caveat Emptor. . .

WANTED: Up-to-date roll chart part no. 425-001806 and manual for Philco tube tester model 9100. Top dollar paid. Gerald Moore K8AYJ, 5305 Woods Rd., Sidney MI 48885.

COLOR ORGAN KITS $3.25 up. IC power supplies $2.75 to $8.50. Computer grade electrolytic capacitors $.35. Xmtr transistor TRW PT3690 $4. Catalog. Murphy, 204 Roslyn Ave., Carle Place NY 11514.

Men From MARS Are Friendly At Phan Rang

by Maj. John Tabor

Phan Rang AB, Republic of Viet-

AMECO PT, modified for high power. Barefoot xcvr use only; xcvr must have extra spst normally-open relay contacts. $40. Paul Snyder WA3HWI, 7940 Gilbert, Philadelphia PA 19150.

2 METER: HEATH Twoer, $25; Motorola 41V ac/dc, mike, xtals, $45; SCR-522 Professionally converted. RECEIVERS: "Super-Pro," $50; Heath Chyenne MR-1, 80–10 SSB & power supply, $40; misc power supplies. Carl Heintz WB6RXC, 2635 Oak Knoll, San Marino CA 91108 (213-283-5296).

DTL INTEGRATED CIRCUITS: Guaranteed new - gates 70¢, buffers 80¢, F/F 90¢, dual F/F $1.15 - add 20¢ for postage. Also other inexpensive parts. Lists & prices from Mitch-Lan Electronics Co., Dept. 870, P.O.Box 4822, Panorama City CA 91412.

FOR SALE: Heathkit two meter transceiver Model HW17-A. This unit has been factory aligned and checked. Price $100. Lee Jamison, 3461 Via Barba Lampoc CA 93436.

FM MOBILE UHF Transceiver, RCA CMU-15A.(12V), all accessories. Fleet turn-in. Each $50. Matched pair manual $90. Gordon W2MPT, 25 Norma, Lincroft NJ 07738.

JOHNSON VALIANT, like new, $75. Johnson Viking II with VFO, $40. Johnson Rotator with indicator, $35. K6MXN, 3231 W. 13th St., Hawthorne, CA. 213-7

TOWER HEADQUARTERS! 12 Brands! Heights Aluminum 35% off! Antennas—20% off! Galaxy, Hammarlund, Gonset, SBE at discount. Catalog—20¢. Brownville Sales Co., Stanley WI 54768.

SELL: DRAKE 2B with Calibrator and Speaker, asking $165.00; Heath DX60, asking $50.00; 2 Motorola Hiband P-2550 Handy Talkies as, $35.00, $50.00 for both. John Fearon, 3384 Peachtree Rd. NE, Suite 705, Atlanta GA 30326.

"HOSS TRADER ED MOORY" says he will not be undersold on Cash Deals! Shop around for your best cash price and then call or write the "HOSS" before you buy! New Equip-

FM MOBILE TRANSCEIVER 450 MHz, 2-channel trunk mount RCA rig in perfect condition. Fully duplexed and operating as a mobile telephone. Includes transmit crystals for 442.12 and 442.05; receive crystals for 448.82 and 448.85. Crystals are from Sentry and are enclosed in ovens. Complete less control head and cables: $100. Will throw in two 4 dB Com Prod mobile gain antennas. Ken Sessions K6MVH/1, RFD 2, Peterborough NH 03458.

WORLD RADIO's used gear has trial-terms-guarantee! Gonset 910A — $179.95; SR160 — $149.95; Swan 350 — $289.95; Swan 400/420 — $299.95; HT40 — $49.95; Apache — $99.95; DX60 — $49.95; T4X — $319.95; HQ180AC — $349.95; SP600JX (rack) — $269.95; Galaxy R530 — $649.95; 75A3 — $209.95; Drake 2A — $149.95. Free "blue-book" list for more. 3415 West Broadway, Council Bluffs IA 51501.

FOR SALE: HRO5 coils E, F, G, H, J, JA. HRO60 dial. Make offer for all or any part. Wells Chapin W8GI, 2775 Seminole Rd., Ann Arbor MI 48104.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class License, plus "Self-Study Ability Test," Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

HAMFESTERS 36th ANNUAL HAMFEST and picnic. Sunday, August 9, 1970, Santa Fe Park, 91st and Wolf Road, Willow Springs, Illinois, southwest of Chicago. Exhibits for OM's, XYL's. Famous Swappers Row. Information and tickets, Tom Ondriska WA9YZW, 6609 South Kedvale, Chicago IL 60629.

40th ARRL WEST GULF DIVISION CONVENTION July 17, 18—19, Orange, Texas. Come by car, plane, or boat, but come to the fun, fellowship and entertainment. A bargain you can't afford to miss. Registration $8.50. Orange Amateur Radio Club, Box 232, Orange TX 77630.

and 50.01-50.1. Unfortunately the FCC went along with the ARRL and decided to use punishment instead of reward in the matter of frequency allocations. It seems to me like a pretty cheap copout for the ARRL to now try and shift some of the blame for the catastrophe they brought on us onto someone who did everything possible to try and stop them from doing this.

One Dollar a Copy?

Perhaps you have noticed that only two of the four ham magazines appear on the newsstands. The reason for this may not be readily apparent. I won't go into the details of this problem, but the plain fact is that few, if any, magazines are able to turn a profit on their newsstand sales.

Most magazines are able to charge enough for advertising to make up for the newsstand losses, but in our field we have the advertising rates held artifically to about one fourth those of just about any other field (for comparable size magazines) by nonprofit tax-free QST. They are not on the newsstands, so they don't have to make up for these losses. The idea behind the low ad rates, I believe, is that this is supposed to keep down competition. It hasn't, but it has kept the competition struggling to try and break even with magazines that would in any other field be big money makers.

If we kept the size of 73 down to that of CQ, used cheap junky paper and printing, and made our writers whistle for their money, we probably could break even on newsstand sales. But our much larger magazine, with more articles than all the other magazines combined, fast and high payment for authors, plus everything else has kept the newsstand operation strongly in the red for the last year. The dollar price should allow us to break even, and that is considered by many businessmen today as being a runaway success.

nam (7AF) – "To be successful in this business you have to be friendly, patient, and like people," explained the noncom-in-charge at the base Military Affiliate Radio System station.

Air Force Staff Sergeant Robert L. Johnson from Henderson, N.C., handles the MARS station within the 1882d Communication Squadron. The local staff handles about 1300 phone calls per month for airmen to locations in the continental United States and the Pacific area.

"Not only do we place calls home for personnel at Phan Rang AB, we also receive calls for them from relatives and friends in the United States," stated Airman 1st Class Larry D. Orsak from Wichita Falls, Texas.

Outgoing calls fall into three categories: Red Cross priority, chaplain priority, and routine. The Red Cross and chaplain's calls usually are for emergencies and are put through as soon as possible.

"The great majority of our calls are routine, however," stressed the genial noncom, "and they usually concern promotions, base assignments, and 'R&R' which is by far the most popular subject."

When a serviceman desires to make a call to the United States, for example, he places his name on the waiting list. As soon as it comes up, the MARS operator on duty will place a call to an Air Force MARS or Civilian Affiliate station in the United States. The stateside operator in turn dials the requested telephone number.

The only expense to the serviceman is the cost of the call from the MARS station in the United States to the number which he is calling.

Unless the weather conditions are particularly bad, an airman can usually get a call through within 24 hours – often within minutes of his deciding to make the call.

"When you work in the MARS station for a little while, some pretty amusing things happen," chuckles Sqt. Thomas J. Sumpter from Covina, Calif. "Probably the funniest and most frequent mixup is when a serviceman is matched with the wrong wife, or vice versa. I remember just recently when an airman first class got his call put through to a major's wife in Kansas.

"The conversation went something like this: 'Hello, Honey, this is Bob. How are the kids?' And the answer from the states came back: 'Bob who? And *what* kids?'

While all MARS stations in Vietnam are staffed by military personnel, MARS stations in the United States are manned by both military and civilian stations. The civilian operators freely give their time and money to support the program which brings a touch of home to thousands of servicemen in lonely places around the world.

Vietnamese MARS stations play cupid, too, according to Sgt. Johnson: "We have a marriage coming up later this spring. One of our MARS operators at another base in Vietnam is getting married to a young lady in the United States via the MARS radio network. All MARS operators in Vietnam have been invited to listen in and be witnesses to this unusual marriage by ham radio."

ment: Factory Warranty: BTI LK-2000HD Heavy Duty Linear, $895.00 (Cash Price $689.00): Early Model Swan 260 Cygnet with microphone, $435.00 (Cash Price $339.00): Gonset GSB 201 MkIV Linear, 2000W, $495.00 (Cash Price $329.00): New Rohn 50 ft Foldover Tower Prepaid, $199.95: New Mosley Classic 33 and Demo Ham-M Rotor, $198.00. Used Equipment: R4, $259.00: HT-37, $169.00: 75A-4, $289.00: 2B, $159.00: Galaxy 5, $229.00. Two Locations: Moory Electronics, Box 506, Dewitt AR 72042 (501-946-2820), or Bill Davaul W5FQX, 415 W 33rd, N. Little Rock AR.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd PA 19004.

NOVICE CRYSTALS: 40—15M $1.33, 80M $1.83. Free Flyer. Nat Stinnette Electronics, Umatilla FL 32784.

HELP! Need someone qualified on solid state revrs, have DAVCO DR-30 with no sensitivity, replaced bad rf FET but no improvement, set not butchered, have manual. Tom Gillam KQUIW, CAM RANH Area Exchange, APO San Francisco 96312.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland CA 94610.

GREENE...center dipole insulator with...or...without balun...see November 73, page 107.

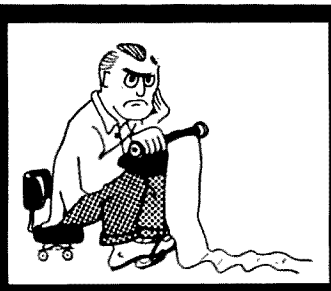
END CARD PROBLEMS. Frame, protect, store or display 200 QSL's in 20-card plastic holders for $3.00, prepaid and guaranteed. Tepabco, Box 198, Gallatin TN 37066.

WANT TO BUY or trade for, TS239. D. Potter, 2844 San Gabriel, Austin TX 78705.

LZ1KSZ desperately needs an i-f filter, any frequency, for his homemade SSB rig. 5 MHz ideal. If you have one to spare, please send it to 73 Magazine or direct to LZ1KSZ, Box 73, Stara Zagora, Bulgaria marked as a "free gift, used radio part, no commercial value."

WOW! Heath Twoer with push-to-talk, $40; Heath DX-60, $50; Johnson Personal Messenger, $40. All excellent. Donald Perriguey, 955 N Catalina, Pasadena CA 91104.

RBB—RBC MANUALS New, $5.00; used, $4.00; OS-8 oscilloscope manual, $3.00; some QST 1929, 30, 31, etc., Radio 1939, 40, 41, etc. Write for list. James W. Holloway W6LFL, 2027 Harton Rd., San Diego CA 92123.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

May I be so audacious as to propose a solution to a whole assortment of problems that are plaguing the FCC and amateur radio? This is consistent with my pleas for solutions rather than problems.

Problem: The FCC took away the amateur 11 meter band and opened 23 channels for business and personal use. The result was, as all of us well know, complete chaos with some 800,000 CB'ers hamming away on those poor little 23 channels. The dimensions of the problem have prevented any reasonable solution. What can be done to straighten all this out?

Problem: Virtually every newcomer to the hobby of radio gets on CB instead of going the old route of SWL and then amateur. A few manage to survive the frustrations of the CB band, but most fall by the wayside, disillusioned, and never get to ham radio. The number of new hams has been disastrously low in recent years and most of us feel that something should be done to reverse this trend. This shortage of new amateurs is already being reflected along into industry, with colleges complaining that there is a substantial drop in students interested in engineering. A cutback in amateurs must reflect itself along as an eventual shortage of engineers and technicians.

Problem: We have one amateur band that is virtually unused and which would easily be lost to us soon if this isn't changed. This is the 220–225 MHz band, which has only dozens of active users, while the 2 meter and 420–450 MHz bands have thousands. There are good reasons why this is so, but it is activity that counts, not excuses; if we don't use 220 it will go away. I think we can put it to a spectacular use.

Proposed solution: How about our having a new class of amateur license, a Hobby Class license, requiring no theory and no code, just a test of knowledge of rules and regulations? This license could permit operation within the middle four megahertz of the 220 band, from 220.5 to 224.5 MHz, thus providing two good-sized buffer bands on each end which would be regular amateur bands (providing more than enough room for the few 220'ers that are active today, as well as plenty of room for 220 crossband repeaters). With 100 watts of power, the Hobby licensees could communicate over 50–100 miles with normal beams. Further, I propose that they be limited to narrowband FM, thus eliminating heterodynes and greatly reducing QRM. I propose that they can use repeaters that repeat to or from their band, but that the repeaters must be operated by higher class amateurs.

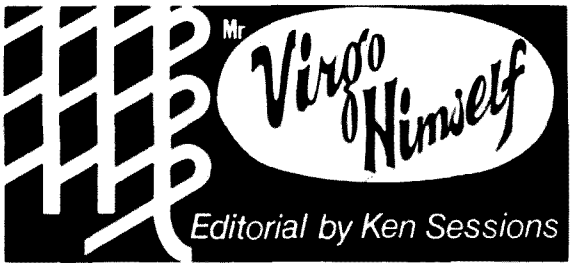
In order to indicate the new license, I propose that a new set of calls be established starting with NA1AAA and following the other amateur radio calls in districts. When an NA (NB, etc.) moves up to a Technician or General license he would receive a counterpart call that is available (WA1AAA or WB1AAA). I propose that this program be funded by the charge of $5 for the license and that the license be valid for five years, renewable.

Such a service should provide an outlet for the hundreds of thousands (and perhaps millions) of people who want a hobby license and who have been using CB to fill this need. It should enable the FCC to move these people up to 220 and get them off the 23 channels so that these can be used as originally intended. The coming loss of skip contacts on 11 meters should help this changeover, with skip enthusiasts being able to transfer their operations to repeaters and such.

The use of FM techniques will enable millions of operators to use these frequencies without serious QRM problems. I do think that the signals should be stabilized, but that crystal control should not be required. I think that something on the order of 5 kHz deviation should be a good compromise, keeping down bandwidth, and yet giving us all the benefits of FM. With 15 kHz channel spacing this would permit an adequate number of individual channels in the band – plenty of room for nets and repeaters.

In addition to giving us super activity on 220, which is nice, we would see the rapid development of commercial gear for this band, which would benefit everyone interested in using 220. It would also help the development of 420 and even 1296 by making stabilized FM UHF equipment available at relatively low cost. The day of the $100 FM transceiver is not far off when you have a market of millions of users. Transceivers,

(continued on page 100)



The Convention Scene

Convention watchers ought to keep their eye on the Orlando Hamfest and East Coast FM Convention. This combined meeting is turning out to be one of the biggest shows in the East. Two adjacent motels (Hilton and Jamaica) were booked for the occasion, and both were filled to capacity with advance reservations.

At the Hilton, an exhibit area was set up indoors and a "swap-type" flea market was formed in the nearby parking lot. The flea market was so active on Saturday (first day of the weekend hamfest) that getting into and out of the exhibit area was difficult. The exhibit area was laid out rather poorly by Hal Shea W4BKC, who managed to resist all suggestions for improvement. Prize drawings, for example, were conducted just inside the entranceway, so that getting in or out of the building during the drawings was virtually impossible.

Also, Shea managed to string several booths into an area that doubled as a meeting place. It didn't seem to disturb him that activities in these booths conflicted with activities in the meeting area. Fortunately for the Orlando Hamfest, however, Shea's bumbling was restricted to this single level of responsibility. There were enough conscientious planners and workers to see that the convention was a success anyway.



A repeater goes up at the East Coast FM Convention in Orlando, and everybody helps. There's a lot of standing around to be done when a repeater goes up, and these fellows are doing it. Sam Carson adjusts the gain on his hip-mounted Handie-Talkie while John Perry makes preliminary checks of the repeater's coverage. The fellow grinning is Enyaw Neerg, 73's ace subscription salesman. In the background Gene Rhodes and Lou Goldstein examine the solid-state Touchtone decoders and the digital identifier to be used in the repeater when it gets permanently installed.

The FM boys from the Brevard Repeater Association put together a mobile relay station, complete with 70 ft tower, diplexer, and solid-state identifier, and installed it right at the Jamaica motel. The range was not as great as a mountaintop machine, but it certainly extended the coverage of the walkie-talkies carried by so many visiting FM'ers.

The sidebanders held a special dinner, and Wayne Green spoke briefly to the guests. After dinner, he showed a series of slides he'd taken during his recent trip to Jordan – which included photos of the American embassy taken right after the incident. (Wayne was in Jordan when it happened.) He also had some interesting views on the Arab-Israeli conflict and gave a first-hand report on the reasons for so much anti-American sentiment in Jordan.

The convention was rained out on Sunday. Like California, Florida gets fickle sometimes and provides rain when it's least wanted. The downpour all but shut down the flea market, but it seemed to have no great impact on the indoor activities. As a matter of fact, they probably benefited by the situation.

In all, the convention was an outstanding success. Hal Shea stated that some 3500 amateurs attended. Figuring a probable error factor of 50%, that brings the number to maybe 1800 – still a success by ham convention standards.

Candid Encounters

Whoever invented the ham convention deserves to be immortalized in some hall of fame somewhere. The convention, you see, is like ham radio itself – you meet people face to face, get to know them better. I can't think of a better way to demolish preformed opinions. I met Dick Cowan at a convention recently, for example. Now, to you newcomers, that name may not mean anything, but to the oldtimers, it ought to be pretty familiar. Dick Cowan is the publisher of CQ, 73's nearest competitor.

My preformed opinion of Cowan, I must admit, was negative. I had only recently read a full-scale attack on the character of Wayne Green in one of his editorials, and as a result I had decided that this was a petty, troublemaking personality whom I definitely would rather not meet. But I did meet him. And, oddly enough, I liked him. He seems nowhere near as imposing in person as he does in his vitriolic anti-Green prose.

As a matter of fact, when we got to talking, I learned that he wasn't really all that anti-Green in the first place. He said he ranked Wayne as a genius who could do more single-handedly than many magazines can with a whole staff. Back in the old days, he said, when Wayne was editor of

CQ, Cowan would tear his hair out wondering how the monthly deadlines would be met. Then, right at the last possible second, in would walk Wayne. The whole building would go into a state of siege and chaos would reign. But then, as if by magic, the whole magazine would suddenly be finished, and ready for the printer. Cowan's apparent antagonism seems to stem from the painful fact that he no longer has a Wayne Green to perform that monthly magic. Actually, Wayne should feel flattered.

It was a convention that gave me the chance to renew acquaintances with another, less threatening, competitor. At Dayton, I spent a lot of time with Skip Tenney and Jack Morgan, publisher and ad manager of Ham Radio magazine. This was a particularly interesting experience because I watched them get involved in 2 meter FM, a new mode of operation for both of them. They both returned to New Hampshire with new Varitronics radios. Their initial CQs and AM-type S-meter readings embarrassed me a little at first, but they soon got the hang of FM operation. Now they're on quite a bit, and we chat once in a while through the local repeaters. So I learned that those folks over there in Greenville really aren't all bad; as a matter of fact, they're downright lovable once you get to know them.

Conventions have other advantages, too. They expose people to new ideas. At the recent Orlando convention, I saw diehard sidebanders get converted to FM. The prospect of carrying a hand-held transceiver to a ham get-together was just too tempting for them, and they succumbed. Art Housholder, of Spectronics (Oak Park, Ill.) may have been largely responsible. He carried one of Motorola's newest dream things: a pocket-sized FM transceiver that puts out 5 watts and has a receiver that matches even the largest and best. (The price tag would scare you away, but the thing does have the power to impress you even if you aren't the impressionable type.)

I really shouldn't have said those sidebanders were "converted," because that isn't exactly true. Their interests were expanded to *include* FM, but not as a replacement for their regular bands and modes. One of the fellows, in fact, told me that he was going to get on 2m FM just so he could keep active at conventions. And he said he knew quite a few DX'ers who keep in contact with each other via FM when their regular band is hot; if one of the group spots something rare, he passes the word over the FM "intercom."

Conversion is a two-way street, too, I might add. I looked and sounded pretty ridiculous working 20m sideband when Wayne was in Jordan. Not only was I totally unfamiliar with the traditional "list" style of DXing, but I had almost forgotten how to tune in a sideband station. As it happened, I got bit by the bug, though, and now find myself sitting at Wayne's Galaxy all too frequently, working stations halfway around the globe. (Got me some good ones, too.)

ARRL Sees It Our Way

73 and QST are in almost complete agreement on the FCC's repeater proposal. In QST's June issue, the ARRL listed comments that amounted to an almost 100% replay of 73's April and May comments, a fact that should lend solidarity to the amateurs' position on Docket 18803. Briefly, here are the results:

Docket 18803 Recommendation	73 Comment	and month	QST Comment	and month
Remote activation only from fixed site	No	Feb. Apr. May	No	June
No intermediate relay for remote control	No	May	No	June
Repeater has failsafe dropout timer	Yes	May	No	June
Repeaters to be tone-coded	Yes*	Feb. Apr. May	No	June
No crossbanding of repeaters	No	May	No	June
Repeaters confined to subbands	No	May	No	June
600W limit	No	May	No	June
Repeater linking prohibited	No	Apr. May	No	June
3-minute ID	Yes	Feb. Apr. May	No	June
Logging relaxation	Yes	Feb. Apr. May	Yes	Apr. June

(* If UHF monitor is not required.)

A quick look at the chart will show that QST and 73 are in real disagreement over no more than two points: automatic dropout timers and 3-minute ID.

The automatic dropout, in 73's opinion, is a good thing. In essence, the FCC proposes to limit single transmissions to 3 minutes, with a timer to assure that the repeater drops out if the timed period is exceeded. This approach offers a built-in safeguard for repeater control when something goes wrong. The wise repeater owner already has such a system installed, because it serves the dual purpose of (1) failsafe control, and (2) discouraging longwinded ragchewers.

The other area of 73—QST conflict is the 3-minute ID rule, an unofficial FCC requirement for the past several years. The ARRL feels that identifying repeaters at 10-minute intervals is satisfactory. 73 does not.

In my early days of FM, while I was editor of FM Magazine, I had the view ARRL has today. It just seemed that 10 minutes was often enough to ID a repeater that's always in the same spot. In practice, though, I learned that I was wrong — as I'm sure the ARRL will in time. Here's why:

Many repeater QSOs do not last 10 minutes. The repeater will be "alive" for two or three minutes, dead for a few more minutes, then active again perhaps five or six minutes later. With a repeater, it's hard to know where a given QSO starts and ends, because the contacts often just run together. With a repeater ID'ing once at the start of a QSO, then every 10 minutes thereafter, experience shows that actual ID may only occur every half-hour or so with a reasonably active repeater — assuming the time is cumulative with a COR-triggered timer. The only alternative is to have the repeater identify itself whether it is being keyed or not, and there aren't too many repeater boys who want that.

The FCC has learned that IDs are far too few and far between if a 10-minute elapsed-time indicator is used. But with a 3-minute timer operated from the COR, actual identification takes place approximately every 6 minutes while the repeater is in use. This disparity exists because most repeater timers are COR-operated. The timer comes on when a carrier appears, and stops timing when the carrier drops out. No time is logged during the repeater's "extended carrier" operation or during the "squelch tail" and "space" periods between transmissions. Thus, it takes anywhere from 6 to 8 minutes of normal operation to log up 3 minutes of actual use.

If you wonder why cumulative COR timers are so much more practical than simple elapsed-time indicators, just ask the repeater owners. There are plenty of reasons; they're complicated, to be sure, but very valid.

. . . K6MVH

May I entreat you to call upon your best qualities; forbearance, objectivity, maturity, understanding, and tolerance, before you read what I have to say in this editorial? There is a serious and profoundly important issue at stake, and while this is not going to be any sort of statement of my own personal views concerning the substantive questions involved, there is a tangential point which merits examination. In other words, the matter at the heart of this issue, namely the world political situation, is not in question here. I wish to discuss another phase which bears upon it merely as a corollary.



On Saturday, May 9th, on a frequency of 14.292 MHz, a net was organized. It consisted of college club stations and others, and was supposed to be operating for the express purpose of exchanging information with respect to the student demonstration which took place in Washington on that day. Periodically, between these exchanges, and in anticipation, perhaps, of a not unwarranted negative reaction on the part of the casual audience on the frequency, announcements were made, stating that the net was intended to be nonpolitical, and nonexpressive with respect to any views on the war, campus disorders, the Administration, or any such things, but was merely seeking to implement the logistics of the Washington demonstration . . . moving the people, rotating buses, providing emergency medical attention for the ill, etc. There was, however, as it turned out, some propagandizing and political drum-beating, which obviously was inevitable.

On the air, many persons have expressed horror and revulsion at the idea of our ham bands being used for such a purpose. Wholesale comment has been noted, during which some have suggested that the licenses of participants ought to be suspended or revoked altogether. Some have gone even further, and have demanded imprisonment, the imposition of heavy fines, and even loss of citizenship! And a few outspoken intemperates have gone so far as to suggest that all such persons ought to be "stood up against a wall and shot!"

Now, this question is not one to be discussed in an atmosphere of fearful hush-hush or careless facetiousness, for it is a deadly serious matter, demanding sober and prudent coolheadedness. The central core of the question is not whether it is right or wrong to dissent privately from the mainstream opinions held by the majority. The question of the right to hold private opinions has nothing to do with this, for that particular issue was settled long, long ago. I am sure that most of us can and do agree that everyone is entitled to his own opinion.

The core of the matter is whether persons who do dissent shall be allowed to air their ideas on our radio spectrum, which has always been confined to a rather limited range of allowable topics. And, if they are allowed to extend the range of discussion to include some form of dissent, just how far may they go? Must they be restricted to small controversies, or can they open up the whole can of beans . . .let out all the stops . . .and really get to digging into the "gut" issues?

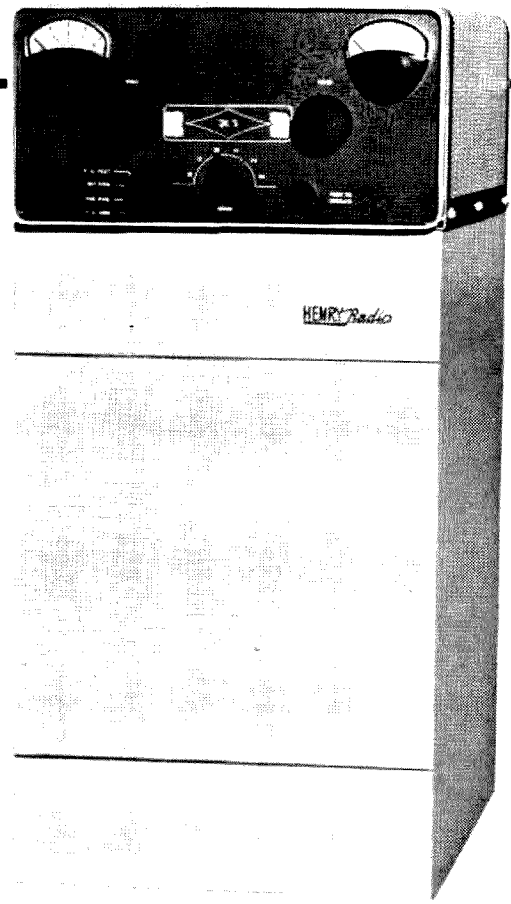
Dissenters are utilizing the campuses, and many of us object to this, regarding it as inordinate license and abuse of privilege. They are using the public streets and squares, and we object to this also. But how about the ham bands? Just where is the point beyond which amateurs may not conduct such activities, or, more specifically, is there such a point? Or, if there is not, ought there to be such a point?

Should the bands be preserved as a sort of ivory-towered vacuum, removed from life and all its ramifications? Should hams be restricted to subjects which are divorced from all vestige of germane relationship to our times and our conditions? Must they avoid visceral issues, and be Pollyannas?

The issuance of a license by the FCC constitutes a grant of privilege. Is this grant limited, carrying an implicit power of censorship, cutting off the ordinary provisions of the First Amendment of the Bill of Rights? Does the holding of a license constitute acceptance on the part of the licensee of a set of behavioral standards, somehow at variance with those which pertain to the rest of the citizenry? In other words, when you take a ham ticket, are you agreeing to waive a significant section of your constitutional rights as an American citizen in good standing?

Are hams, in fact, under an obligation of some sort which compels them to avoid the controversial in all their contacts on the air? Before you reach for any glib or easy answers to these questions, remember just one thing: It has

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. . . Beware of cheap imitations

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never been considered wrong for hams of the opposite persuasion to display at times the most outspoken advocacy of violence imaginable, just so long as it had not been against what is generally referred to as the Establishment. No one seems to take issue with a man who wants to restore capital punishment, to impeach the Chief Justice of the United States, to send all Black persons back to Africa, or to drop a hydrogen bomb on Moscow or Peking. But just once, let someone express some idea which appears to run against the Establishment line politically, and that's when the fur begins to fly. So when you search inside yourself for answers to these dilemmas, I urge you to try to be perfectly fair and objective about it.

Once, at a Veterans' Day Parade on Fifth Avenue, a female spectator shoved a man standing in front of her, because he failed to doff his hat as Old Glory went by. As he fell flat on his face in the gutter, she cursed at him vehemently, calling him a communist SOB. When some less acrimonious persons helped him to his feet, it was seen for the first time that he could not very well remove his hat, since he had no arms! He was wearing a Purple Heart rosette in his lapel, and was also wearing a VFW insignia. This double amputee had sacrificed his limbs in the service of his country, while protecting the life and security of the very one who had pushed and villified him!

All of us have had occasion to observe the excessive zeal of superpatriotic fanatics, who desire every American to conform in dress, haircut, opinion, life-style, religious piety, politics, and so forth. Sometimes the figuratively armless and legless among us must contrive to prove every single day of their lives that they have earned their right to individuality. Yet, that is precisely the cause for which their sacrifices have been made. There is always some zealot, ready and eager to push them down into some gutter, when they fail to salute the flag, don't wear a red "buddy poppy," or don't care to have their kids join the Little League. Among certain people, the very worst transgression of all is the refusal to conform.

When will we learn to recognize the difference between patriotism and blind conformity to convention? There is a vast gulf between the two, yet the line of demarcation is becoming increasingly harder to discern. There really is not much of a generation gap to speak of, so much as there is an adamant refusal to tolerate the next fellow's point of view. Once we can overcome this intolerance, the schisms will be minimal.

In one of these pieces, some time ago, I stated that free speech was very much like pregnancy . . .there's no such thing as a little of it. You either have got it, or you haven't got it. And once you interfere with its progress, or try to limit it in any way, it is destroyed completely.

Now, please bear in mind that all of this has absolutely nothing to do with acts of violence. . . incendiary fires, bombings, stoning the police, unlawful occupation of buildings, destruction of private property, flinging of ordure on the heads of persons in the streets below, looting, burning of draft cards in violation of the law, and so forth. Where such violence occurs, free speech no longer exists. The very idea of free speech. . .its heart and soul. . .exists in the fact that *both* sides of a dialog should have the right to express themselves. Where only one side has the floor, freedom of speech is a mockery. And the majority is not necessarily compelled to grant free speech to the minority, while it gives up its own right to the same privilege. Many persons who wish to be granted all democratic rights because they are expressing minority points of view think that the majority should be silenced. This is just as distorted as the other side of the coin.

Anyone who commits acts of violence, no matter what position he takes on the issue, should be tried, and if convicted, put into confinement. The idea that wrongdoers should be treated permissively on the grounds that they will develop complexes if they are held accountable, is one of the worst causes of violent behavior in our society. We simply cannot afford to allow malefactors to get away with some of these atrocities they commit in the name of Constitutional Rights.

The difference between freedom and license is clearly definable, and society cannot afford to allow the latter to devour and destroy the former!

This nation of ours, almost two hundred years old, can easily endure all the verbal attacks of the dissenters. It can stand all the mealy-mouthed vituperation, the arrant nonsense, the short-sighted ravings of Utopians who propound the false syllogisms of misbegotten political creeds. But this nation cannot survive the rigid, sanctimonious ignoramuses, who, in the name of blind patriotism and conformity, arrogantly demand that everybody must think, talk, and act as *they* do.

No country which demands of its people that they vote 'Ja,' can hope to endure, for such demands grow out of an all-consuming fear. And such fear grows out of a lack of faith in the system, the political institutions, and worst of all, out of a country's failure or unwillingness to recognize and respect the rights of its individual citizens.

God help us on the day when anyone in America, whether of the majority or minority, is muzzled, and cannot freely express his opinions. We have a splendid, unparalleled legacy here, of both liberty and the courage to preserve it. Let us repudiate those fears which tempt us to limit our liberties.

73. . .K2AGZ ■

AN IMPROVED METHOD FOR THE TRANSMISSION OF COLOR INFORMATION BY SLOW-SCAN TELEVISION



Photograph of televising process.

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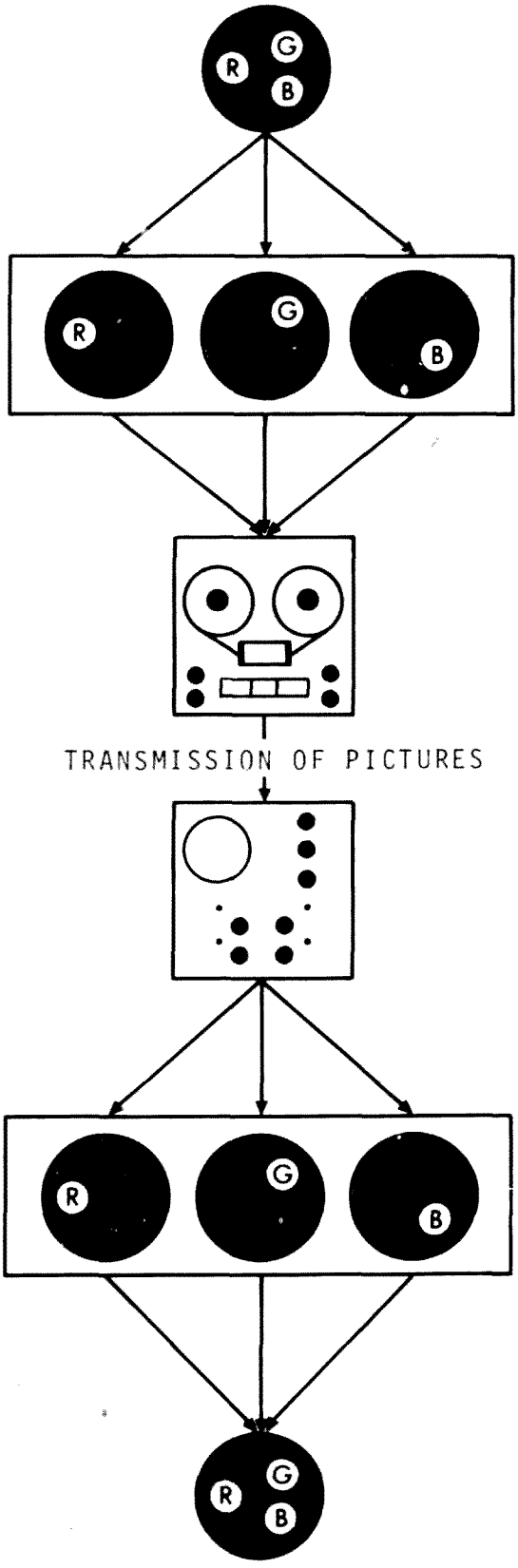
In a recent article (73, Jan. 1970) we described a method for transmitting a color picture by slow-scan television. The method essentially was one of performing a tricolor analysis of the color picture, transmitting the resulting black-and-white separation pictures by slow-scan television, and reconstituting the original color picture using a separable, subtractive synthesis process (Color-Key). The separable synthesis process used had many advantages, including a relaxed registration requirement (small deviations in the size and orientation of the separation pictures can, with care, be corrected in the synthesis process) and a capability for controlled color correction in the fabrication of the reconstituted picture. The method, however, does suffer one major drawback: too many photographic steps are required in the synthesis phase. The method we now describe contains at most two photographic steps. As these steps can involve the use of Polaroid film, it is now possible to produce, both quickly and economically, a good reproduction of a color picture transmitted by slow-scan television.

Method

The improved method proposed for analyzing and synthesizing a color picture is shown in Fig. 1.

The subject – here a set of red, green, and blue circles on a black background – is photographed three times, once each time through a red, a green, and a blue filter. The three black-and-white separation pictures (positives) so produced are then televised and tape recorded; transmission of the taped pictures proceeds via high-frequency SSB, the telephone, or the mail. Upon receipt, the separation pictures are displayed on an SSTV monitor, and three successive time-exposures of the separation pictures are photographed *on a single color film frame* through corresponding red, green, and blue filters. When this film is developed, a reproduction of the original color subject should result.

Basic to this method of color analysis and synthesis is a strict registration requirement. As the actual color synthesis is done *within the camera containing the color film*, correction of magnification or positional differences in the separation pictures is, for all practical purposes,



ORIGINAL COLOR SUBJECT

PHOTOGRAPH COLOR SUBJECT THROUGH RED, GREEN, AND BLUE FILTERS. SEPARATION PICTURES MUST BE IN REGISTER.

TELEVISE, IN REGISTER, THE BLACK AND WHITE SEPARATION PICTURES; TAPE ON CONVENTIONAL AUDIO TAPE RECORDER.

DISPLAY, IN REGISTER, THE BLACK AND WHITE SSTV SEPARATION PICTURES

TAKE THREE SUCCESSIVE TIME EXPOSURES THRU RED, GREEN, AND BLUE FILTERS. ALL THREE EXPOSURES MADE ON ONE COLOR FILM FRAME.

SYNTHESIZED COLOR PICTURE

Fig. 1. Improved method for transmission of color information.

impossible. Thus, in the analysis phase, it is absolutely necessary that the three black-and-white pictures be photographed and televised in register. In synthesizing the color reproduction, no relative movement between the SSTV monitor and the film camera, or changes in the scanning dimensions, can be tolerated.

The method described here is similar to that investigated by Davies (1964) for use in the Surveyor moon-probe program. In working with color film processes, Davies employed both Polaroid Polacolor and Kodak Ektachrome film. Objections raised by Davies to the use of these films were:

1) Polacolor film lacked dynamic range.
2) Photographs had a blue cast resulting from the blue hue of the monitor screen.

The latter fault is somewhat negated by the use of P7 phospors (blue-green) in SSTV monitor screens. Should additional hue correction be required, however, variations in f/stop settings and filter densities can be instituted in the final photographic step. It should also be noted that in the developing process for Polacolor film, a shorter developing time will bias the print towards the red end of the spectrum. In printing pictures from films such as Ektachrome the use of color-correction filters is common practice.

Lack of dynamic range in Polacolor film is not so great as to deter use of this film in amateur SSTV work.

Color Analysis

The method described was tested using the picture shown in Fig. 2. To aid in the synthesis process, red, green, blue, light gray, and black chips were mounted beneath the picture; accurate reproduction of the color chips assured proper rendition of the main color subject. The subject card was photographed through the necessary filters with a Polaroid Model 110B camera. Type 47 Polaroid black-and-white film (ASA 3000) was used and a closeup lens was attached to the camera. Filters used were: red (Wratten 25A), green (Wratten 58B), and blue (Wratten 47). The subject picture was indirectly illuminated by four 300W photoflood lamps. Every precaution



Fig. 2. Color subject. Photo courtesy VARIG Airline.

was taken to insure the three separation pictures remained in absolute register – that is, that the camera did not move between exposures.

The three black-and-white separation pictures resulting from the analysis process were carefully aligned and mounted on a keyed cardboard backing. In the televising process, this keyed backing was shifted relative to a fixed piece of keyed cardboard, insuring proper alignment of each picture in front of the SSTV camera (Fig. 3). The three separation pictures, televised in register, were recorded at 3-3/4 ips on standard 1-mil Mylar audio tape.

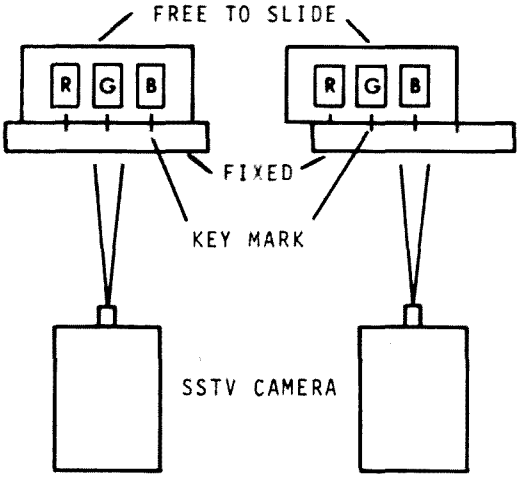


Fig. 3. Alignment method used in televising process.

It is possible, with some SSTV imaging systems, to do direct color separation with the SSTV camera. Slow-scan systems employing 931A photomultiplier tubes (Hutton, 1968) or conventional vidicons such as the 6326 (Taggart, 1968; Hutton, 1969) have spectral response functions suitable for use in direct color separation (Cohen and Tarr; 73, Jan. 1970). Slow-scan vidicon tubes, however, peak in the blue-violet, and cameras employing these tubes (Macdonald, 1965) can not be used for direct color analysis. As a camera employing a WL-7290 vidicon was used in the present work, it was necessary to perform the color separation by photographic means.

Color Synthesis

The separation pictures were displayed on a 3 in. hybrid monitor employing a 3RP7A cathode-ray tube (CRT). The Polaroid 110B camera, now loaded with type 48 Polacolor film (ASA 75), was rigidly fixed in front of the monitor. To minimize relative camera-monitor movement, the camera shutter was not used, and a black card placed before the lens between exposures. All work was done in a completely darkened room. No changes in monitor control settings were made between a given set of time exposures. Some experimentation with exposure time was necessary to produce an acceptable Polacolor print. The direction such experimentation took was influenced by careful analysis of preceding exposures. For the type CRT and film used, we found it necessary to photograph 8 frames of each separation picture, through its respective filter, at an f/stop setting of 4.7. The room temperature, 75°F, dictated a developing time of 60 seconds.

Results & Conclusions

We have demonstrated a method for quickly and economically analyzing and synthesizing a color picture. At most, two photographic steps are required, both of which can involve the use of Polaroid quick-processing film. Careful attention must be given to insure registration of the black-and-white separation prints. However, by exercising care, amateurs should now be able to use this method to transmit color information by slow-scan television.



Fig. 4. Synthesized color subject.

The synthesis of the color subject is shown in Fig. 4. This picture was obtained on the third try. To the extent that the color in the reconstructed picture matches the color of the original subject and the color chips, we classify the picture quality as "good."

Acknowledgment

We thank D.J. Holscher, Hughes Aircraft Company, Culver City, California, for supplying a copy of D.R. Davies' report. Subject photo courtesy VARIG Airline.

W4UMF and Wade Tarr ■

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Worldwide ITU Prefix/Call Area

AAA–ALZ	United States of America
AMA–AOZ	Spain
APA–ASZ	Pakistan
ATA–AWZ	India
AXA–AXZ	Australia
AYA–AZZ	Argentina
A2A–A2Z	Botswana
BAA–BZZ	China
CAA–CEZ	Chile
CFA–CKZ	Canada
CLA–CMZ	Cuba
CNA–CNZ	Morocco
COA–COZ	Cuba
CPA–CPZ	Bolivia
CQA–CRZ	Portuguese Overseas Provinces
CSA–CUZ	Portugal
CVA–CXZ	Uruguay
CYA–CZZ	Canada
C2A–C2Z	Nauru (Republic of)
DAA–DTZ	Germany
DUA–DZZ	Philippines
EAA–EHZ	Spain
EIA–EJZ	Ireland
EKA–EKZ	USSR
ELA–ELZ	Liberia
EMA–EOZ	USSR
EPA–EQZ	Iran
ERA–ERZ	USSR
ESA–ESZ	USSR (Estonia)
ETA–ETZ	Ethiopia
EUA–EWZ	USSR (Belorussia)
EXA–EZZ	USSR
FAA–FZZ	France, Overseas Territories & Overseas States of the French Community
GAA–GZZ	United Kingdom
HAA–HAZ	Hungary
HBA–HBZ	Switzerland
HCA–HDZ	Ecuador
HEA–HEZ	Switzerland
HFZ–HFZ	Poland
HGA–HGZ	Hungary
HHA–HHZ	Haiti
HIA–HIZ	Dominican Republic
HJA–HKZ	Colombia
HLA–HMZ	Korea (Republic of)
HNA–HNZ	Iraq
HOA–HPZ	Panama
HQA–HRZ	Honduras
HSA–HSZ	Thailand
HTA–HTZ	Nicaragua
HUA–HUZ	El Salvador
HVA–HVZ	Vatican State
HWA–HYZ	France, Overseas Territories & Overseas States of the French Community
HZA–HZZ	Saudi Arabia
IAA–IZZ	Italy & Territories Under Mandate of United Nations
JAA–JSZ	Japan
JTA–JVZ	Mongolia
JWA–JXZ	Norway
JYA–JYZ	Jordan
JZA–JZZ	Indonesia (West Irian)
KAA–KZZ	United States of America
LAA–LNZ	Norway
LOA–LWZ	Argentina
LXA–LXZ	Luxembourg
LYA–LYZ	USSR (Lithuania)
LZA–LZZ	Bulgaria
MAA–MZZ	United Kingdom
NAA–NZZ	United States of America
OAA–OCZ	Peru
ODA–ODZ	Lebanon
OEA–OEZ	Austria
OFA–OJZ	Finland
OKA–OMZ	Czechoslovakia
ONA–OTZ	Belgium
OUA–OZZ	Denmark
PAA–PIZ	Netherlands
PJA–PJZ	Netherlands West Indies
PKA–POZ	Indonesia
PPA–PYZ	Brazil
PZA–PZZ	Surinam
QAA–QZZ	Service Abbreviations
RAA–RZZ	USSR
SAA–SMZ	Sweden
SNA–SRZ	Poland
SSA–SSM	United Arab Republic
SSN–STZ	Sudan
SUA–SUZ	United Arab Republic
SVA–SZZ	Greece
TAA–TCZ	Turkey
TDA–TDZ	Guatemala
TEA–TEZ	Costa Rica
TFA–TFZ	Iceland
TGA–TGZ	Guatemala
THA–THZ	France, Overseas Territories & Overseas States of the French Community
TIA–TIZ	Costa Rica
TJA–TJZ	Cameroon
TKA–TKZ	France, Overseas Territories & Overseas States of the French Community
TLA–TLZ	Central African Republic
TMA–TMZ	France, Overseas Territories & Overseas States of the French Community
TNA–TNZ	Congo (Republic of)
TOA–TOZ	France, Overseas Territories & Overseas States of the French Community
TRA–TRZ	Gabon
TSA–TSZ	Tunisia
TTA–TTZ	Chad
TUA–TUZ	Ivory Coast
TVA–TXZ	France, Overseas Territories & Overseas States of the French Community
TYA–TYZ	Dahomey
TZA–TZZ	Mali
UAA–UQZ	USSR
URA–UTZ	USSR (Ukraine)
UUA–UZZ	USSR
VAA–VGZ	Canada
VHA–VNZ	Australia
VOA–VOZ	Canada
VPA–VSZ	Overseas Territories for

List

Tnx to W1SWX

	Which The United Kingdom Is Responsible for International Relations
VTA–VWZ	India
VXA–VYZ	Canada
VZA–VZZ	Australia
WAA–WZZ	United States of America
XAA–XIZ	Mexico
XJA–XOZ	Canada
XPA–XPZ	Denmark
XQA–XRZ	Chile
XSA–XSZ	China
XTA–XTZ	Upper Volta
XUA–XUZ	Cambodia
XVA–XVZ	Vietnam (Republic of)
XWA–XWZ	Laos
XXA–XXZ	Portuguese Overseas Provinces
XYA–XZZ	Burma
YAA–YAZ	Afghanistan
YBA–YHZ	Indonesia
YIA–YIZ	Iraq
YJA–YJZ	New Hebrides
YKA–YKZ	Syrian Arab Republic
YLA–YLZ	USSR (Latvia)
YMA–YMZ	Turkey
YMA–YNZ	Nicaragua
YOA–YRZ	Romania
YSA–YSZ	El Salvador
YTA–YUZ	Yugoslavia
YVA–YYZ	Venezuela
YZA–YZZ	Yugoslavia
ZAA–ZAZ	Albania
ZBA–ZJZ	Overseas Territories for Which The United Kingdom is Responsible for International Relations
ZPA–ZPZ	Paraguay
ZQA–ZQZ	Overseas Territories for Which The United Kingdom is Responsible for International Relations
ZRA–ZUZ	South Africa (Republic of)
ZVA–ZZZ	Brazil
2AA–2ZZ	United Kingdom
3AA–3AZ	Monaco
3BA–3FZ	Canada
3GA–3GZ	Chile
3HA–3UZ	China
3VA–3VZ	Tunisia
3WA–3WZ	Vietnam (Republic of)
3XA–3XZ	Guinea
3YA–3YZ	Norway
3ZA–3ZZ	Poland
4AA–4CZ	Mexico
4DA–4IZ	Philippines
4JA–4LZ	USSR
4MA–4MZ	Venezuela
4NA–4OZ	Yugoslavia
4PA–4SZ	Ceylon
4TA–4TZ	Peru
4UA–4UZ	United Nations
4VA–4VZ	Haiti
4WA–4WZ	Yemen
4XA–4XZ	Israel
4YA–4YZ	International Civil Aviation Organization
4ZA–4ZZ	Israel
5AA–5AZ	Libya
5BA–5BZ	Cyprus
5CA–5GZ	Morocco
5HA–5IZ	Tanzania
5JA–5KZ	Colombia
5LA–5MZ	Liberia
5NA–5OZ	Nigeria
5PA–5QZ	Denmark
5RA–5SZ	Malagasy Republic
5TA–5TZ	Mauritania
5UA–5UZ	Niger
5VA–5VZ	Togo
5WA–5WZ	Western Samoa
5XA–5XZ	Uganda
5YA–5ZZ	Kenya
6AA–6BZ	United Arab Republic
6CA–6CZ	Syrian Arab Republic
6DA–6JZ	Mexico
6KA–6NZ	Korea (Republic of)
6OA–6OZ	Somali Republic
6PA–6SZ	Pakistan
6TA–6UZ	Sudan
6VA–6WZ	Senegal
6XA–6XZ	Malagasy Republic
6YA–6YZ	Jamaica
6ZA–6ZZ	Liberia
7AA–7IZ	Indonesia
7JA–7NZ	Japan
7OA–7OZ	South Yemen (Peoples Rep.)
7PA–7PZ	Lesotho
7QA–7QZ	Malawi
7RA–7RZ	Algeria
7SA–7SZ	Sweden
7TA–7YZ	Algeria
7ZA–7ZZ	Saudi Arabia
8AA–8IZ	Indonesia
8JA–8NZ	Japan
8OA–8OZ	Botswana
8PA–8PZ	Barbados
8QA–8QZ	Maldive Islands
8RA–8RZ	Guyana
8SA–8SZ	Sweden
8TA–8YZ	India
8ZA–8ZZ	Saudi Arabia
9AA–9AZ	San Marino
9BA–9DZ	Iran
9EA–9FZ	Ethiopia
9GA–9GZ	Ghana
9HA–9HZ	Malta
9IA–9JZ	Zambia
9KA–9KZ	Kuwait
9LA–9LZ	Sierra Leone
9MA–9MZ	Malaysia
9NA–9NZ	Nepal
9OA–9TZ	Congo (Democratic Rep. of)
9UA–9UZ	Burundi
9VA–9VZ	Singapore
9WA–9WZ	Malaysia
9XA–9XZ	Rwanda
9YA–9ZZ	Trinidad & Tobago

FOR EMERGENCIES: THE SUPER



by Ken Sessions, Jr. K6MVH

When disaster strikes, there's no substitute for thorough, effective, versatile, and handy communications capability. Nothing gives these features quite so impressively as an autopatch. This one is ideal because it does everything – even lets you answer the phone, on command, without tones. Perfect for public service and emergency use, where phone access from hand-held units is desirable.

The most useful single commodity there is when an emergency occurs is communications capability. Not just any communications capability, though; to be useful in an emergency, a communications network must be readily accessible by officials and it must be capable of giving two-way coverage to and from any other single point in the country. Not ham radio, you say? You think the telephone is the only qualifying form of communications here?

Wrong and right, in that order! No one could deny the value of an unencumbered telephone line at the scene of a disaster. A phone can give almost instant two-way communications between any two points at will. Further, those people who *need* to communicate with the "outside world" in an emergency situation are accustomed to using a telephone – they feel more at home, more sure of the results – they'll be less confused at a time when confusion reigns. But of course it is impossible to

AUTOPATCH



Disasters are not respecters of property. When Hurricane Diane hit the town of Putnam, Connecticut, the power and phone lines went, too. The hurricane also brought torrential rains that caused New England rivers to flood many cities and towns along their paths. The only form of communications in such emergencies is the mobile or portable radio units; and these can provide the phone coverage ravaged by nature. (Photo by Motorola News Bureau.)

arrange for a telephone line to be ready and waiting at the site of the next disaster.

So let's take a look at what we've always considered to be the next-best thing: a ham radio traffic network. On the plus side, such a net can give the officials what they need most: a means for communicating. But a negative aspect is the fact that the choice of places where direct two-way communications can be maintained is restricted to places where amateurs are stationed. And communications effectiveness is hampered to a certain extent by the officials' inherent unfamiliarity with a ham radio setup. We've all seen the official who wants to talk to his contact while the contact himself is transmitting. Ham radio simply takes some getting used to.

The modern ham can, however, offer a disaster communications system that offers all the advantages of a conventional telephone, plus the capability of working into and through an organized message network. The secret is operating a simple autopatch in conjunction with an existing FM repeater.

Use of an autopatch offers a number of advantages that even Ma Bell can't match. For example, the official who wants to initiate a telephone call need not leave the area where he is needed in order to find a telephone. He can access the repeater autopatch through a hand-held walkie-talkie or from the amateur's car. (If the autopatch is built around a UHF repeater, say the control facility for a 2 meter

repeater, the official should feel particularly at home, for he won't be able to tell the autopatch from a regular telephone – he'll be able to dial directly, enjoy full duplex, etc.)

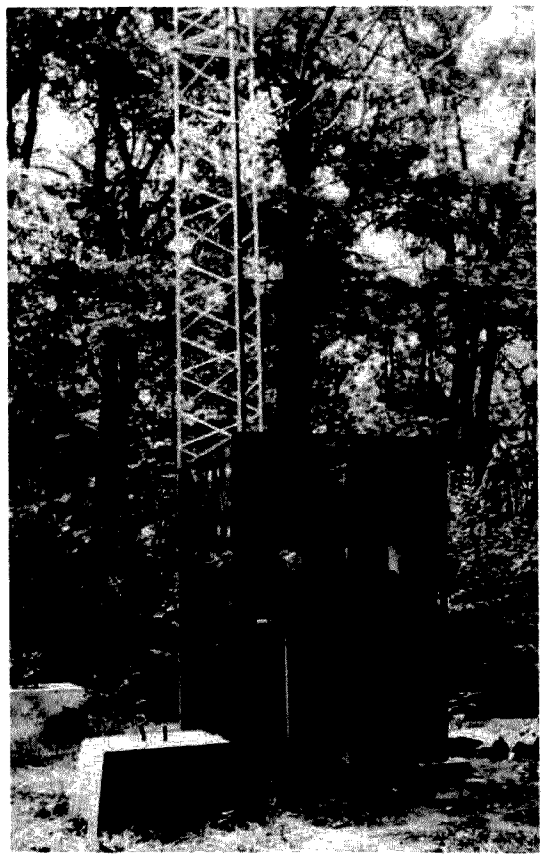
One of the most obvious disadvantages of a landline in an emergency is that *there may be no landline after the disaster strikes*. A flood could wash away the phone poles. A jet crash might take out all the lines in the vicinity of the site. Disasters of all kinds – fire, tornado, hurricane, earthquake – all have a habit of wiping out the telephone service in the vicinity of where the phone is needed most. But with an autopatch, the phone line may be far removed from the disaster scene. The chances of a landline outage at the repeater site occurring simultaneously with a disaster somewhere else are slim indeed.

One thing is certain. Bring a telephone to the site of a disaster and you'll be one welcome fellow. If you are already operating through a repeater that has public service ties, those ties will be strengthened immeasurably by adding telephone capability.

There is no guarantee, of course, that operating a telephone-interconnected repeater from a portable or mobile installation will be legal after the FCC gets through fiddling with repeater rules. But even the FCC would have to agree that an autopatch is certainly in the best interest of the public, which is what ham radio is all about when you get right down to the basics of the issue. A sensible approach, then, would be to proceed with plans for increasing the usefulness of your system, having faith that the Fed will not tighten the vise later.

Legality of Radio/Telephone Autopatch

A great many amateurs seem to think it is illegal to interconnect a telephone with a repeater for automatic patching. As my own remote control license will attest, this is simply not true. The legality of a remotely operated telephone system depends on its ability to meet the requirements of FCC Rules and Regulations. The principal requirement is that incoming calls must not be capable of keying the transmitter when no licensed operator is monitoring from the control point.



Most autopatches are simply phone patch panels installed at a remote repeater site where telephone service is available. Often, owners of commercial remote installations such as the one pictured here will permit amateurs to install an autopatch-equipped repeater. The key word is service, and no facility fills the bill more perfectly than a ham repeater whose users are prepared to act fast in an emergency. (Photo by Motorola News Bureau.)

Another area of questionable legality is that of controlling a remote station from a mobile unit. The FCC says that a remote station must be controlled from a fixed site. To many, this automatically precludes the possibility of setting up a control station in the mobile. But close scrutiny of Part 97.43 of the Rules reveals no prohibition of mobile control. The currently popular interpretation of the Rules is that control can be accomplished from anywhere as long as fixed control is maintained.

Some amateurs even go further, and do not maintain a fixed control *per se*. They say they get their authority to control exclusively from a vehicle because of the

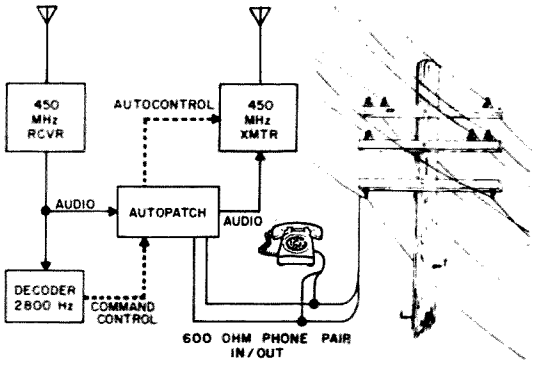


Fig. 1. The autopatch's interconnection with the phone line has no effect at all on an existing telephone connection since it is wired in parallel with the instrument. The block diagram shows how a fully duplexed autopatch system is set up with a UHF repeater.

permission to do so given by the conditions on the back of the amateur license. According to the statement on the reverse of General and Technician class licenses, the remote control point is considered "fixed" even though it may be actually mobile or portable. (Take a good look at the back of your license; it pays to read the small print.)

Not all individual officers of the FCC go along with wording on the back of the license, I hasten to add. James Barr, for example, who happens to be an FCC wheel, says the control station must be fixed – the disclaimer on the license notwithstanding. But Barr might have a rough time making his opinion stick when the official documentation plainly counters it.

In spite of all those hair-splittings, no one within the FCC has ever been known to deny the legality of mobile control *as long as a licensed fixed station is manned by an operator authorized to turn the remote system off should the need arise.* (Docket 18803 would change this, however, if it goes through.) And even Barr has gone on record as endorsing *subcontrol* (which is what exists when a mobile operator controls a remote station that is capable of being controlled by an overriding authorized control station).

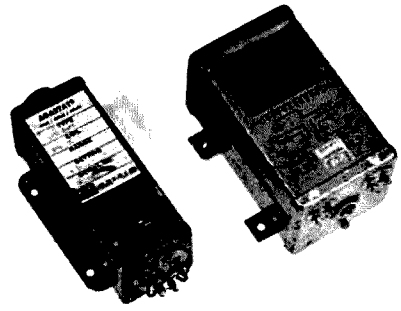
Understanding the Telephone

The conventional telephone uses but two wires to accomplish what may amount to a multitude of different functions. There is typically a low voltage dc level across the line to drive the carbon microphone element. When the telephone rings, however, a higher voltage ac signal is superimposed on the line pair to energize the bell in the instrument.

A telephone with its receiver on the hook is an open circuit. The circuit closes when the receiver is lifted, introducing a moderately low-resistance load (several hundred ohms). The dial is a rather complex switch device that has the capability of opening the circuit briefly for a number of times that correspond to the number dialed. The circuit stays closed as the finger hole is brought around to the stop. Then, circuit "opens" are pulsed out sequentially as the dial returns to its "home" position. Thus, the dialing function could be simulated by rapid manipulation of the hang-up button, provided that the required speed of 10 switching operations per second could be maintained manually. And hang-up could be effected (temporarily) by controlled positioning of the dial.

The "Super" Autopatch

The block diagram of Fig. 1 shows the method by which an automatic patch such as the one described in this article is interconnected into a UHF repeater. The broken lines represent control signals and the solid connecting lines represent audio signals. As can be seen, the telephone needs no modification, and is interconnected with the system by merely tapping into the two wires that are already part of the



Agastat pneumatic timers are perfect for autopatch applications because they can switch plenty of current, they are instantly resettable, and they offer a high degree of reliability. The unit at left is a standard adjustable time delay relay (TD1, TD2, TD3 in schematic of Fig. 2); at right is a delayed dropout. Units are available surplus for $3 to $5 each.

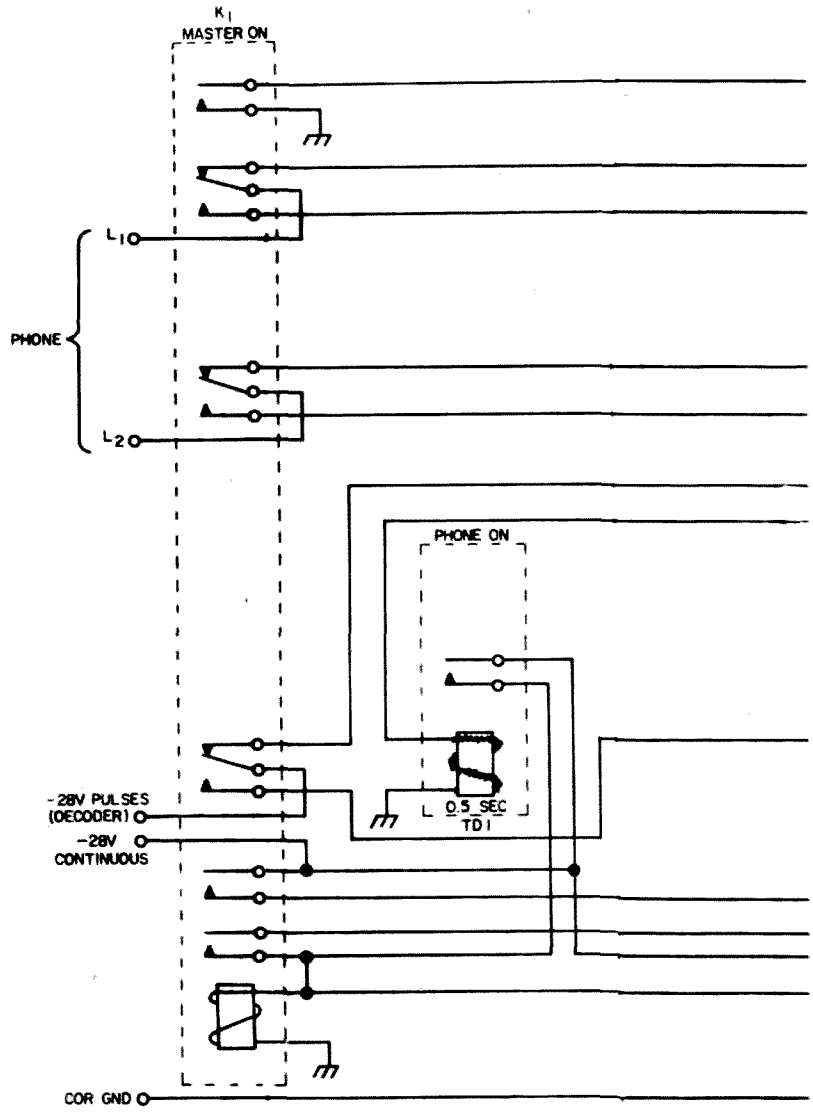


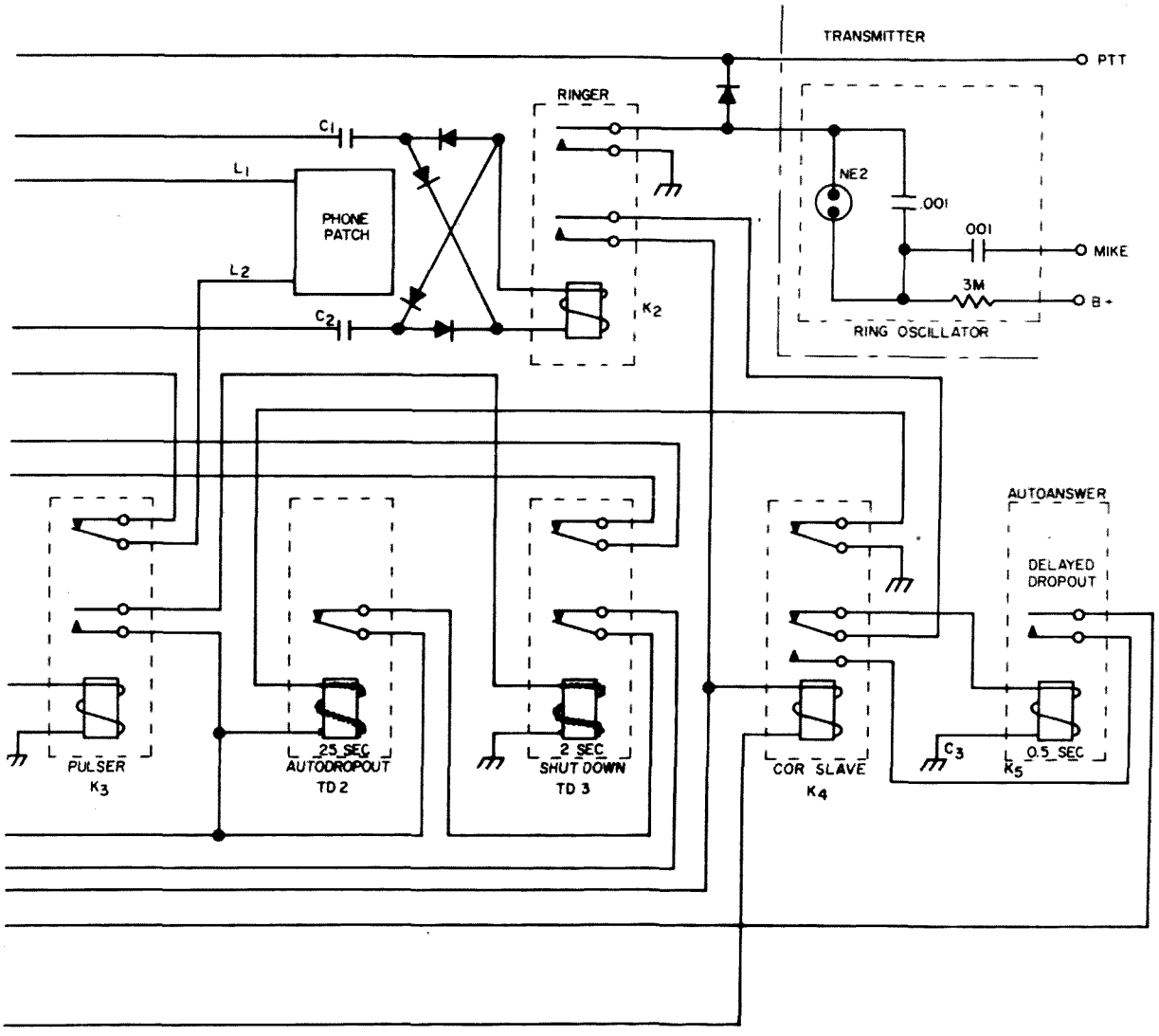
Fig. 2. This autopatch circuit has everything: timed on, timed off, autoanswer from units that are not tone equipped, and a number of built-in "failsafe" features to assure control even if you lose control.

existing telephone circuit. It should be noted that the autopatch can be integrated just as easily into a 2m repeater, though duplex operation would be next to impossible to achieve for the user mobiles because of frequency proximity and attenuation problems.

The autopatch itself performs the magic. Shown in Fig. 2, the circuit contains all the elements necessary to make it the "cadillac" of automatic patching devices. It does just about everything. In response to timed control tones transmitted by the control operator, it can "lift the receiver from the hook" and interconnect the phone patch with the repeater; or it can "replace the phone on the hook" and disengage the repeater. When the phone rings, the control operator knows he has an incoming call: the autopatch generates its own tone and turns on the repeater transmitter with each ring.

Without the need for tones, the control operator has the capability of allowing the phone patch to be engaged or not, as determined by the sequence by which he activates the carrier of the control point transmitter. And, as a final safety measure, the autopatch disengages from the repeater when there is no control signal immediately apparent. If, after the control operator engages the phone patch, he loses control or his transmitter drops off the air, the patch disengages itself in seconds, shutting off the repeater transmitter until control can be reestablished.

Ring Indication. Since the autopatch is likely to be incorporated into an already existing repeater setup, the circuit has been designed for full compatibility. The phone



line at the repeater site can be continuously monitored for incoming landline calls without disrupting the normal operation and control functions of the repeater. During normal repeater use, the phone line is sensed for the presence of an ac voltage (which would indicate that the phone is ringing). The two lines of the twisted pair are fed through a set of normally closed contacts on the main relay (K1) to a bridge rectifier circuit. The dc component of the line is isolated by placing 0.5 μF capacitors in series with the conductors. A sensitive plate relay on the output of the bridge pulls in when the telephone rings and keys the repeater transmitter for the duration of the ring. This momentary closure of the relay triggers a signaling device so that when the transmitter is thus keyed, a ring signal is generated also.

The ringer shown in the upper right corner of Fig. 2 is nothing more than a simple relaxation oscillator; it can be constructed in a few minutes with a couple of capacitors, a resistor, and a neon lamp. The device shown generates an unstable tone that is easily identifiable at the receiving end.

Timer Considerations. The "super autopatch" makes extensive use of timers for effective active and passive control. The timers used in my own autopatch are Agastat pneumatic delay devices made by Elastic Stop Nut Corporation (ESNA), of Elizabeth, N. J. If purchased new, these delays can be quite expensive. I bought mine at a bargain price of $1.50 each from "Pappy" Dow, a Southern California surplus mogul.

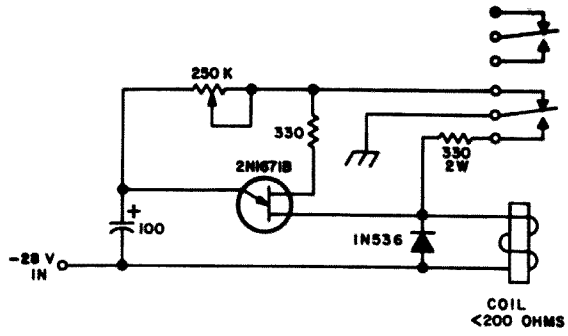


Fig. 3. This unijunction timer circuit offers a broad range of delay periods, from less than 0.5 second to more than 3 minutes. The delay is set by the 250 kΩ pot; each 10 kΩ of resistance gives a second or so of delay. In practice, of course, the pot would be replaced by the proper fixed resistor, because there would be no need for a variable time delay.

All-transistor timing and switching circuits work quite well, but their incorporation does make the schematic a bit more complicated because of the various polarity requirements. The cheapest way to miniaturize would be to compromise a bit by using hybrid timer circuits that employ miniature relays for switching in combination with unijunction timer circuits.

Figure 3 is an adaptation of a timer circuit that was published in GE's "Transistor Manual, Seventh Edition." This circuit is particularly versatile because it employs a low-cost semiconductor, relatively few parts, and an easy-to-find relay with a coil resistance of 150–200Ω.

The Phone Patch. The phone patch itself is an item that warrants some attention, but a great deal has been written on this subject in the past so I won't go into it in detail here. As references, I will cite the FM Repeater Handbook (Editors and Engineers, Ltd., Indianapolis, Indiana), FM Magazine (July 1968 and December 1968), FM Anthology, Volume II (73 Bookshop), and 73 Magazine ("VHF Operation by Remote Control," August 1968).

The most important point to remember when connecting a phone patch into an autopatch system is to leave a dc path through the patch primary. If a series capacitor is placed in the circuit, it should be shorted; otherwise telephone ringing and dialing cannot be effected automatically for remote operation.

"Desirable" characteristics for commercial phone patches are: (1) a high degree of signal isolation, (2) automatic compression circuitry, and (3) built-in preamplification for phone signals.

Autopatch Decoder Control

In the system described here, a high-frequency tone decoder is used to switch a −28V signal for control of the autopatch when a call is to be initiated. The decoder shown in Fig. 4 is ideal for this purpose, having stood the test of time and use. This unit, by the way, is a simplified version of Motorola's transistorized decoder (Part 9-SP022563), which is itself available from Spectronics, 1009 Garfield, Oak Park IL, for $40 postpaid.

The original Motorola circuit is not satisfactory for dial pulsing because it is slow-responding. The Motorola version is used as a "single-tone" controller, where a stable, continuous tone is needed. Removal of a few circuit elements, however, makes the Motorola decoder a natural for phone pulsing applications. (The circuit of Fig. 4 is a quick-pulsing decoder that responds easily to tone pulses of a 10 per second repetition rate.)

Tone Frequency. The decoder is set to respond to tone signals in the frequency range of 2200 to 2900 Hz. Adjustment of the frequency-sensitive elements permits the pinpointing of any 50–75 Hz bandwidth within that range.

Of course, any frequency between 600 and 3000 Hz can be used, but the lower frequencies have serious disadvantages in practical applications. At frequencies between 600 and 1000 Hz, for example, ordinary conversation causes decoder triggering, and the result is errant and inadvertent operation of the functions to be controlled. Frequencies from 1 to 1.5 kHz can also be triggered by occasional voice signals; and a playful repeater user can toy with the phone by simply whistling.

Things begin to get more secure as the frequency goes up. But at 3 kHz, the audio processing capability of the transmitting and receiving equipment may be exceeded, particularly if there is inherent audio distortion in the system. The range from 2.25 to 2.85 kHz should prove ideal: It's difficult to voice-trip, it resists whistle-on

attempts, and it is well within the frequency-response limits of most commercial FM units.

Decoder Alignment. Since impedances are critical when making voltage measurements at the decoder input terminals, an electronic ac voltmeter (vtvm) will be required. With the voltmeter connected across the receiver's audio output leads, have one of the repeater users transmit a tone. With the tone on the incoming signal, adjust the 500Ω pot on the decoder input for a reading of 400 mV. If this is not obtainable, set the 500Ω pot to midposition and adjust the receiver audio gain control. (If the receiver "speaker" audio connects directly to the transmitter, repeater levels will have to be readjusted.)

Next, connect the voltmeter (ac range) from the wiper arm of the 500Ω pot to point A of the 50–100 mH inductor, then adjust the inductor for a peak indication on the meter.

Move the voltmeter lead at point A to the cathode of diode D1 (point B), then *slightly* adjust the 50–100 mH inductor for a *dip* indication.

Autopatch Operation

In operation, when the ham operator sends a note of the proper frequency from the remote control point, the decoder switch closes, applying a –28V signal to the phone patch "master on" relay (K1). Look now at Fig. 2, to see where the –28V decoder-pulse terminal is on the autopatch unit. During the time the operator sends a tone, the negative-voltage signal is applied through the normally closed contacts of K1 and the normally closed contacts of shutdown timer TD3 to the coil of "phone on" timer TD1. At the end of the period of TD1, exactly one-half second, the coil energizes to supply power to the coil of the "master on" relay, which latches in the energized position.

When K1 is latched on, the phone patch is in the circuit and the decoder output is connected to pulser K3. If the operator's tone generator is connected to a telephone dial so that tone pulses can be transmitted, K3 can be used to dial any number. Pulser K3 interrupts the dc circuit of the phone line to accomplish this. At the end of the phone conversation, transmittal by the operator of a continuous tone will hold pulser K3 in. A second set of contacts on K3 feeds the coil of a shutdown timer, which will pull in after a 2-second period to completely disengage the autopatch.

Malfunction Protection. An autopatch is a borderline thing with a respect to official sanctions; it thus behooves the builder to take every precaution possible to see that failsafe measures of every kind are included. The schematic of the autopatch shown here includes a feature that shuts down the patch if the remote operator does not transmit at least one brief signal

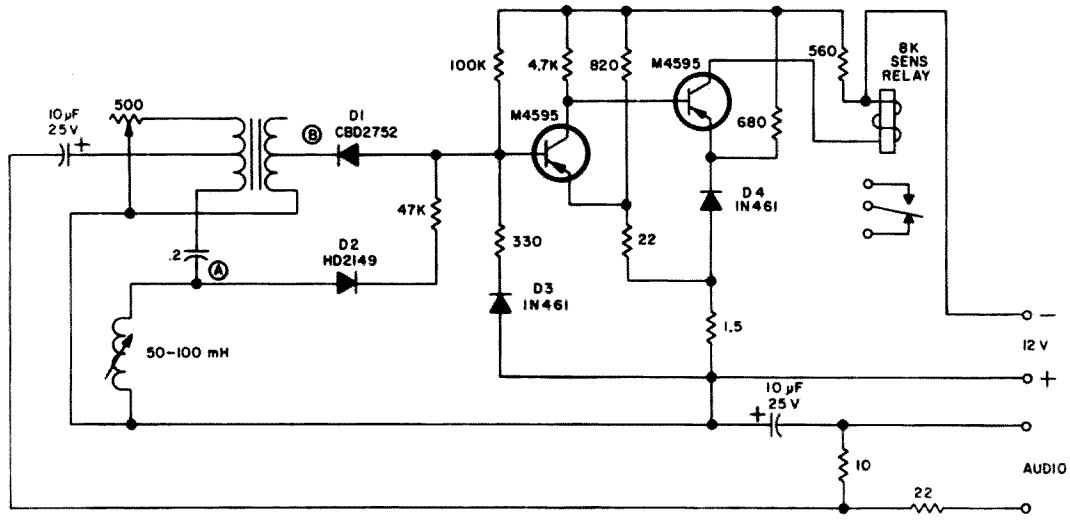


Fig. 4. This audio decoder responds to signals in the frequency range of 2200–2900 Hz. Precise setting is explained in the text. Although Motorola part numbers are shown, equivalent values may be substituted.

every 25 seconds or less. If more than 25 seconds goes by without an incoming radio signal, the shutdown timer (TD3), supplied through the normally closed contacts of the carrier-operated relay, will break the circuit supplying the latching voltage to the "master on" relay.

Most repeaters already are equipped with timers that shut down the repeater if a signal stays on too long, so none was included in this patch. The two schemes are perfectly compatible, and they do complement each other in such a way that when an operator cannot demonstrate that he has control, the phone patch will turn itself off automatically. To effectively demonstrate control, the operator must not talk – during any single transmission – longer than the safety timer of the repeater, and he must transmit a signal at intervals of 25 seconds or less.

Control Without Tones. To answer the phone quickly when it is ringing, the operator can engage the phone patch with the tone as described earlier. Or he can do it, without tones, by transmitting a carrier at a precise time. If he transmits the carrier too soon or too late, the phone will keep on ringing and will not be answered. The autoanswer feature is performed with ringer K2, the COR slave (K4), and autoanswer relay K5 (a delayed dropout relay with a period of 0.5 second).

When the phone rings, ringer K2 energizes only during the period of the ring. The closed contacts of K2 during the ring apply a –28V signal to the delayed dropout relay (K5) through the normally closed contacts of the carrier-operated relay. Thus, K5 is energized for one-half second beyond the ring (or beyond actuation of the carrier-operated relay). If, during the ring, a carrier is placed on the repeater input, a –28V signal is routed to the "master on" relay. The signal must go through the contacts of the ringer, the COR, and the delayed dropout relay; if all three are not energized at the same time, the telephone cannot be turned on without tone control.

If a repeater user is transmitting at the time the telephone starts to ring, the autopatch will not be engaged because the COR cannot feed voltage to the delayed-dropout relay. If he waits until after the ring to transmit, the phone won't answer because the ringer contacts will be open. To answer, the operator must press his transmit key after the phone has started a ring but before the ring has stopped. This concept serves to prevent inadvertent telephone energization yet gives control of the phone to such non-tone-equipped units as handie-talkies.



Twin antennas mounted on the rear cowls keep the author's installation from looking junky. Inside the car, the only visible evidence of a rig is the "Princess" telephone, mounted to the console and modified to serve as a "control head."

On Convenience and Necessity

If you read 73's comments to the FCC's proposed rulemaking for repeaters, you probably saw a reference made to use of an amateur autopatch to save the life of a peace officer. The telephone system used was the one described in this article, and the operator was Don Milbury W6YAN. Don passed the scene of a tragedy involving a highway patrolman and telephoned the police and ambulance directly using his mobile amateur facility. A few miles further down the road, Don accepted a telephone call in his car. The police called him back to express appreciation for his early report and were happy to relate that the officer would live. It will take a lot of ugly towers and TVI complaints to water down at least this one city's opinion of amateur radio.

. . . K6MVH ■

Elliott S. Kanter W9KXJ
3242 W. Hollywood Ave.
Chicago IL 60645

How To Build A Keyer

(and retain your appliance operator status)

Many articles have been written on the subject of building a keyer mechanism for an electronic keyer. The common denominator in all of these projects is that two stationary terminals be placed in some manner and a flexible blade be moved from side to side to make contact with them to form the dots and dashes.

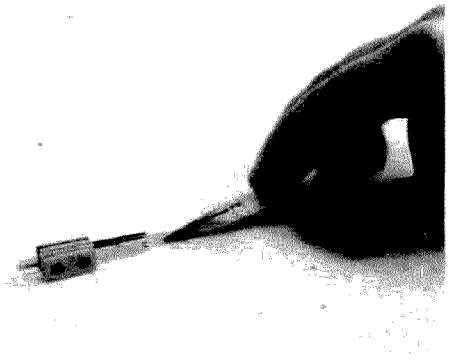
Each article I have reviewed calls for some complex machining operation or using a modified part from a surplus relay. Or a hacksaw blade or some other piece of scrap springy material. More often than not, the simple procurement of the part required costs more in time and energy than would a part specifically designed for the purpose.

There is, however, one commercially produced assembly which costs around a dollar, has contacts rated at 3A, and seems to be a natural for applications such as keyer mechanisms. The part, a switch stack, manufactured by Switchcraft Inc., is a formed-spring switch assembly complete with mounting lugs, solder lugs, and silver contact pads.

The photographs show the three simple steps required to make the Switchcraft part (AA03AA*) into a keyer mechanism.

The first step is to straighten out the middle spring and center it midway

*The Switchcraft stack switch assembly may be ordered for about one dollar from Allied Radio or Newark Electronics, Chicago, Ill.; consult their industrial catalogs for applicable part numbers.

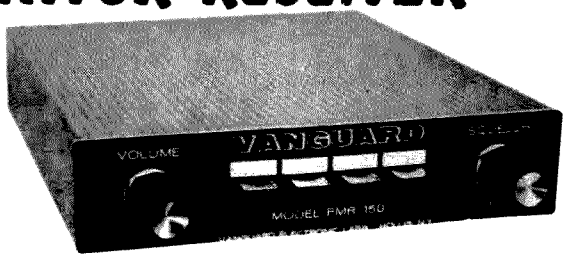


The center spring section has to be spaced equidistant between the two contact points. A pair of long-nose pliers will do the job in a jiffy.

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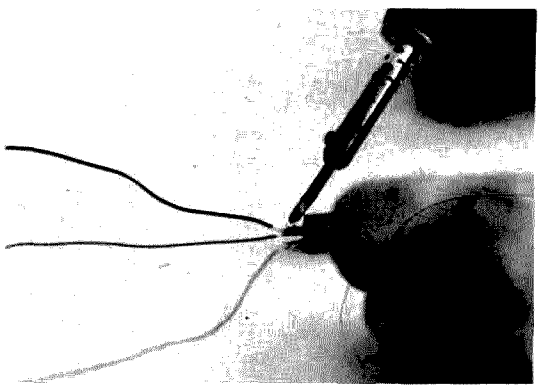
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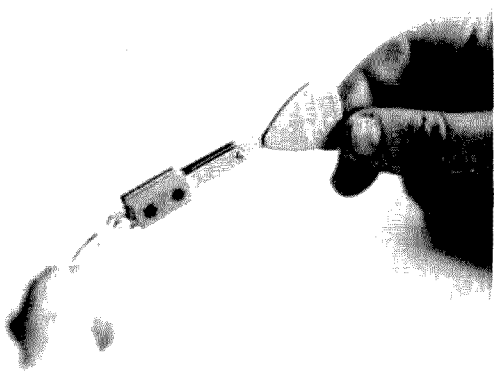
Solder flexible leads to the three contact terminal points so the switch assembly can be mounted without necessity for later access.

between the two outer springs. Long-nose pliers work fine for this job. Next, solder a length of flexible wire to each of the three solder lugs. Now mount the keyer assembly to your board case or what have you with a pair of L brackets made from some scrap metal; use the mounting holes on the assembly and regular screws. No special insulating precautions are required.

The final step is to epoxy two guitar picks to either side of the center spring; then you are ready to hook it to the keyer.

Actually, you will find that it took longer to read this article than to build your keyer. Not only have you become a homebrewer, but the silver contacts add professional reliability to your project. And that sense of "I did it myself" will certainly make this simple project worth all the more to you.

Elliott S. Kanter W9KXJ ■



When guitar picks are glued to the contact spring, the assembly really begins to look like a keyer.

R. Gary Hendrickson W3DTN
1510 Jupp Road
Glen Burnie MD 21061

a 2-Channel Search-Lock For FM Receivers

This simple gadget turns a two-channel rig into an automatic scanning type, and provides the added capability of locking on a channel where activity is sensed.

Many amateurs live in an area where the local repeater output is not on the same frequency as the simplex activity. Installation of a "search-lock" scanner will permit you to monitor both frequencies at the same time, on a conventional 2-channel receiver. Included is an optional active channel indicator that lights up to tell which channel is in use. It can be used with any tube-type receiver such as GE Progress Line, Motorola Sensicon series, or any other receiver that uses separate oscillators for each channel. It can be built into a fixed station or a mobile unit with little modification to the basic equipment.

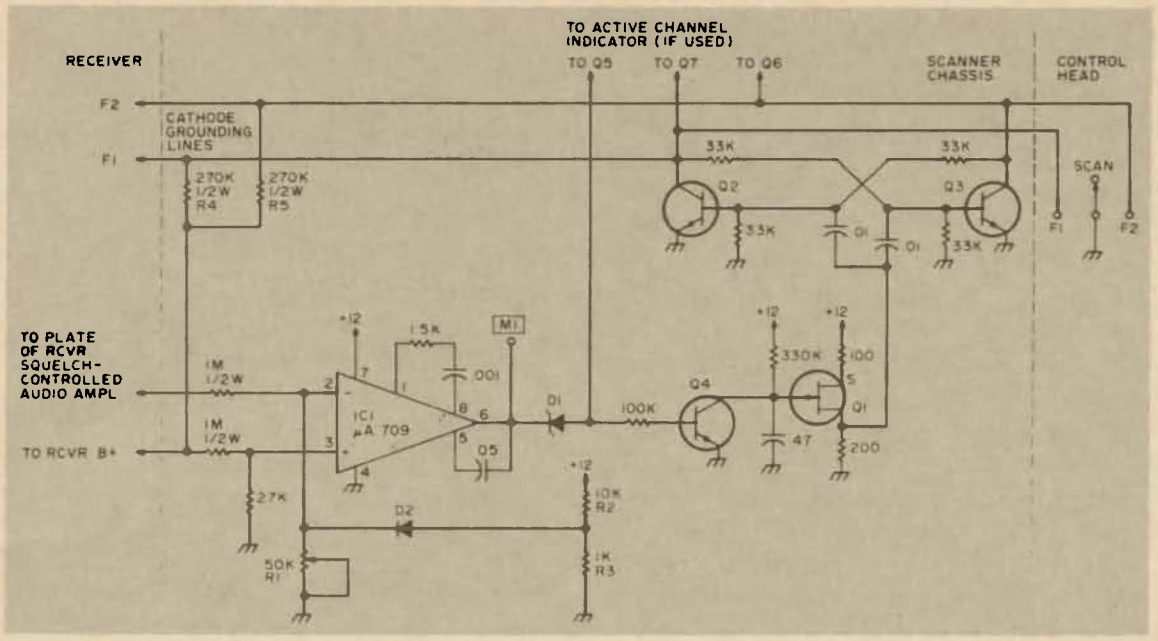


Fig. 1. Two-channel search-lock for FM receivers. The switch is mounted on the control head; everything else may be mounted inside the radio cabinet.

How it Works

The search-lock unit (Fig. 1) consists basically of a flip-flop (Q2 and Q3) with the outputs connected to the cathodes of the two crystal oscillator tubes. As the flip-flop operates, it alternately grounds the cathode of each crystal oscillator for a short time, thus sampling each frequency for a very short period. The flip-flop is triggered by pulses generated by unijunction transistor Q1, at about a 10 pulse-per-second rate. Therefore, each channel is sampled five times per second, for 100 ms each time. This sampling rate is fast enough that no information is lost at the beginning of any received transmission, yet slow enough to permit the crystal oscillators to turn on completely and come up to full output. It is also long enough to allow the squelch to open if a signal is present on one channel. I did not use a faster sampling rate because many crystal oscillators take up to 20 ms to reach full output, and it takes up to 40 ms for the squelch to open on some receivers when a signal is received.

When a signal appears at the receiver input and the squelch opens, the gate circuit will turn off the unijunction transistor pulse generator, and the receiver will stay locked on that channel as long as the signal is received. In this respect, the circuit is similar to that of a carrier-operated relay. The gating circuit consists of a squelch detector (IC1), and gate amplifier (Q4). IC1 is a type 709 operational amplifier wired as a differential switch. I used this circuit because it effectively prevents drift of the gate trigger level with changes in battery voltage when used in a mobile installation.

The positive input of the differential switch (IC1) is connected to receiver B+, and is the reference voltage. The negative input is connected to the plate of the squelch controlled audio amplifier tube.

When no signal is being received, the dc voltage on this plate is the same as B+. When a signal appears and the squelch opens, the dc voltage at this plate will drop. This voltage change is detected by the differential switch (IC1), is amplified by Q4, and switches pulse generator Q1 off.

Potentiometer R1 is the differential switch threshold adjustment. If B+ varies up or down due to a change in battery or line voltage, the differential switch will not operate because it is only sensitive to changes in the ratio of the two input

voltages (and not to changes in the absolute values of these two voltages).

Resistors R4 and R5 provide a "pullup" voltage on the cathodes of each oscillator (switching point in the receiver) to make certain that they go completely off when not grounded through their associated transistor in the flip-flop. They also absorb any leakage currents through either flip-flop transistor.

A switch on the control head is the only operating control needed. It is a three-position type (up, down, and center), and the center position is "on." In the center position, the search-lock operates normally. In either extreme position the associated cathode is grounded directly, and the search-lock is disabled. (See Fig. 2.)

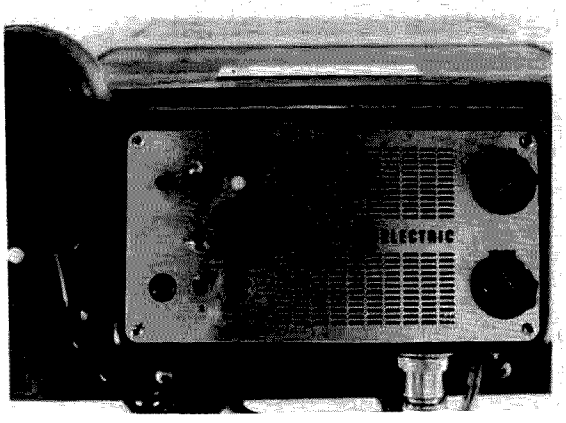


Fig. 2. Search-lock controls mounted on a GE Progress Line front-mount control head. Separate transmitter and receiver channel switches are used. The scan switch is the toggle mounted just under the main power switch. In the extreme left position, the receiver locks on frequency 1, and in the extreme right position, it locks on frequency 2. The center position allows the receiver to scan, thus locking itself on whichever channel becomes active first. The two lamps mounted adjacent to the lower toggle switch provide an indication as to which channel is being used.

The active channel lamp indicator circuit (Fig. 3) is an optional operating convenience that may or may not be included. Transistor pairs Q6 and Q8, and Q7 and Q9, are the lamp drivers. They are controlled by squelch gate amplifier Q5 and inputs from the flip-flop (Q2 and Q3).

When there is no signal present, the lamp drivers are gated off, and neither

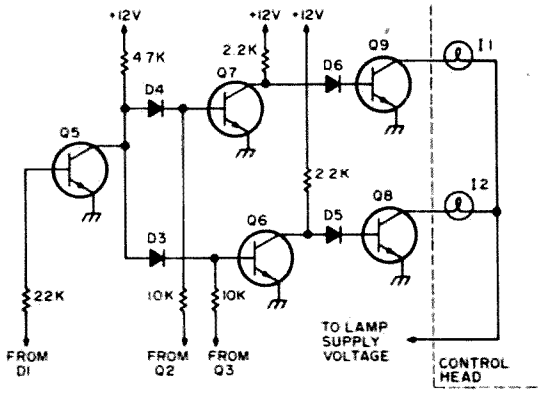


Fig. 3. Optional active channel lamp indicator circuit. The lamps are mounted on the control head.

lamp lights. This was done to eliminate any flashing lights which might be a distracting safety hazard while driving at night. When a signal appears, gate amplifier Q5 turns on, the appropriate lamp driver circuit is turned on, and the lamp lights. As soon as the signal disappears, the lamp goes out, and the search-lock resumes operation. Resistors R2 and R3 and diode D2 serve to keep the squelch gate circuit turned off when transmitting so the channel indicator lamps don't light.

If used in a mobile installation, the entire unit can be powered directly from the 12V battery line. If used in a fixed

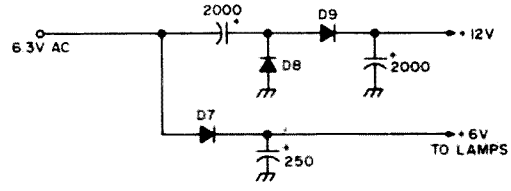


Fig. 4. The ac filament voltage typically available in a tube-type base station can be used to power the search-lock device if this simple rectifier circuit is built.

station, the rectifier power supply in Fig. 4 can be used to supply dc voltage from the filament line. In this case, 6V lamps should be used. (For mobile operation, 12V lamps should be used.)

Construction

Any form of construction may be used. I built my unit on small terminal strips and

mounted them on a plug-in Vector board (Fig. 5). Parts layout is not critical. Small quarter-watt resistors may be used except where noted, and low-voltage capacitors are also satisfactory. Diode D1 is a 1N747, Motorola HEP-102, or similar low-power zener diode of 3–5V. Diodes D2 through D6 are low-power silicon computer diodes such as 1N629 or Motorola HEP-154. Diodes D7 through D9 are low-voltage, low-power silicon rectifiers such as 1N645, 1N2069, or Motorola HEP-154.

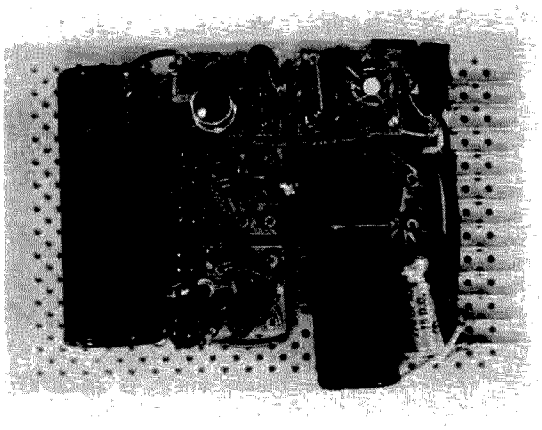


Fig. 5. All components for the search-lock are mounted on a plug-in Vector board.

Unijunction transistor Q1 can be a 2N2160, 2N1671, GE X-10, or Motorola HEP-310. Integrated circuit IC1 is a type 709 operational amplifier. All the semiconductors can be purchased for about $10, including IC1, from Poly Paks in South Lynnfield, Mass. Transistors Q2, Q3, Q5, and Q6 can be 2N3641, 2N706, GE-17, Motorola HEP-50, or any similar type. Transistors Q4 through Q7 can be 2N3565, 2N3860, GE-17, Motorola MPS-6520 or HEP-55, or any similar type. The lamps should be low-power types that do not draw over 150 mA.

Take the usual precautions when soldering to avoid overheating the semiconductors.

Installation

The chassis can be installed inside the case of a mobile unit or anywhere in a fixed station. The only modifications necessary are to separate the receiver channel switching lines from the transmitter lines. Separate switches for transmitter and receiver should be mounted on the control head (Fig. 6). The transmitter switch can be any type with the proper number of positions required for the particular installation.

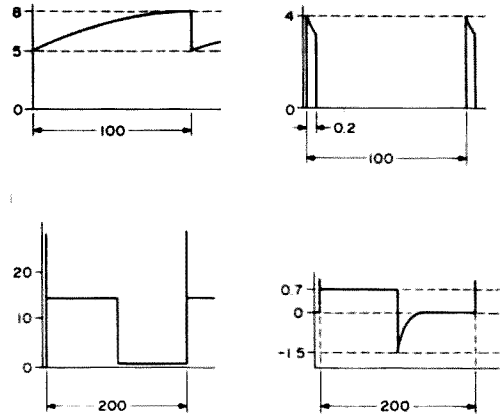


Fig. 6. Waveforms that may help troubleshooting. Waveforms represent a no-signal state, squelch closed. Vertical scale is dc volts; horizontal scale is time (milliseconds).

If you elect to include the active channel indicator lamp circuit, the two lamps will have to be mounted on the control head, and lines run to the search-lock chassis. If the existing control cable doesn't have enough conductors to handle the separate receive and transmit channel switching, plus the indicator lamps, another multiconductor cable can be run to accommodate these wires.

Adjustment

The only adjustment necessary is to set the squelch gate threshold pot (R1). This is done by reading the voltage at metering point M1, the output of IC1. With no signal at the input and with the squelch fully closed, adjust R1 until this voltage drops to just under 2V. Check to see that this voltage rises almost to the supply voltage when you open the squelch.

Troubleshooting

When operating normally, with no signal, metering point M1 should be under 2V, pulse generator Q1 should be generating short pulses at about 10 pps, the flip-flop should be operating, and the lamps, if used, should be out. When the squelch is opened, either manually or by a signal, metering point M1 should rise to near the supply voltage, pulse generator Q1 should not be operating, the flip-flop should be stopped with one side turned on and the other off, and one lamp should be lighted.

The voltages in Table I and the waveforms in Fig. 7 may help when troubleshooting.

Table I. Approximate Voltage Requirements.

	Q1		Q2		Q3		Q4	
	E	B#1	B	C	B	C	B	C
Squelch closed[1]	6.0	0.40	0.4	7.0	0.4	7.0	0.4	6.0
Squelch opened[2]	0.1	0.39	0.6	0.1	0.1	14.0	0.6	0.1

	Q5		Q6		Q7		Q8	
	B	C	B	C	B	C	B	C
Squelch closed[1]	0.4	1.2	0.7	0.6	0.7	0.6	0.4	12.0
Squelch opened[2]	0.6	0.7	0.7	0.6	0.4	1.3	0.4	12.0

	Q9	
	B	C
Squelch closed[1]	0.4	12.0
Squelch opened[2]	0.7	0.1

	IC1							
	1	2	3	4	5	6(M1)	7	8
Squelch closed[1]	–	3.0	2.9	0	–	1.1	12.0	–
Squelch opened[2]	–	2.7	2.9	0	–	11.0	12.0	–

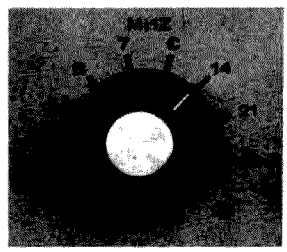
[1] no signal
[2] squelch opened, channel 1 on, channel 2 off.
Some voltages in the upper row are averages of fluctuating readings while unit is searching.

Conclusion

I have been using this circuit in a GE Progress Line desktop station for over a year, and in a mobile rig for a couple of years with no problems. It greatly increases the convenience and pleasure of monitoring by knowing that I won't miss a call on one frequency because I'm monitoring another.

. . . W3DTN ■

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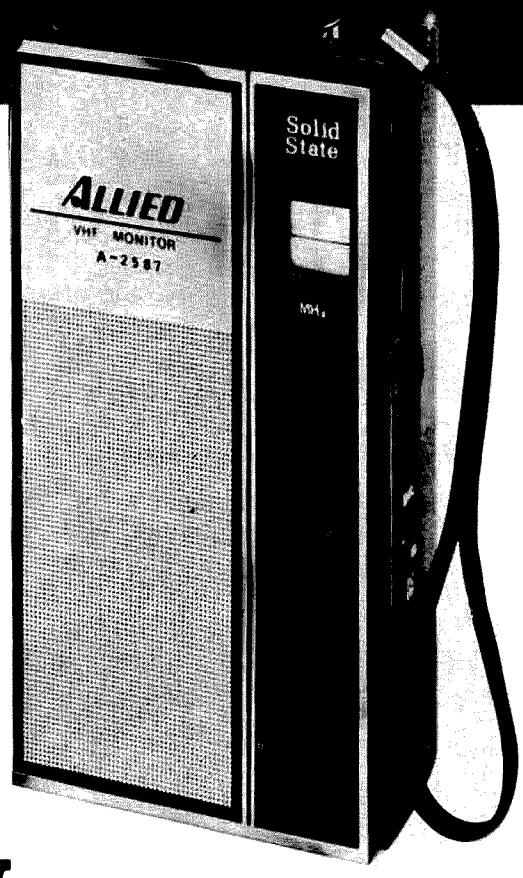
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Allied's Portable FM Receivers



In July 1969, Allied Radio introduced two hand-held transistorized FM receivers. Although these units were designed for monitoring of low- and high-band commercial FM stations, the coverage of the receivers include the 10, 6, and 2 meter amateur bands. The A-2586 receiver covers 27-50 MHz (actual coverage without retuning is 26.5 to 52.5 MHz) and the A-2587 receiver covers 146-175 MHz (actual coverage is 145.5 to 178 MHz).

Initial setup of the low-band A-2586 consisted of putting four penlight batteries (included!!) into the unit. A quick tune across the spectrum showed considerable activity on the CB frequencies, local police frequencies, and the low end of 6 meters. The audio output of the receiver was sufficient, but a little reserve might be desirable in noisy locations.

The receiver had no squelch circuit, but the background noise was very low. Only when a station was transmitting would the audio level increase. This gave the receiver the appearance of having squelch without the actual circuitry. An earpiece, included with the receiver, allows private listening.

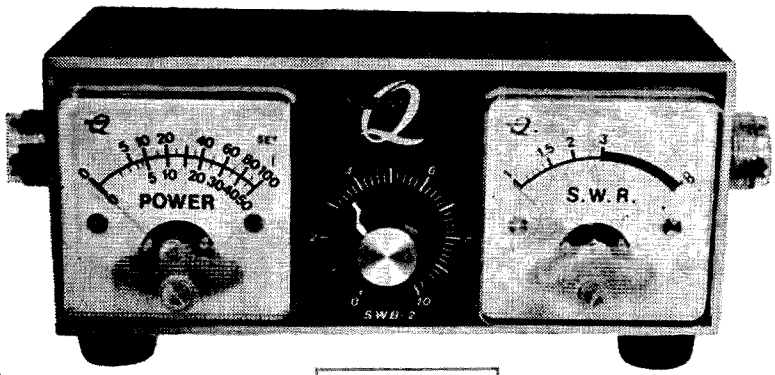
The receiver is quite stable and is fairly selective. Two local police departments have frequencies separated only by 40 kHz. When tuned to one frequency, only slight splatter from the other was heard. Since Allied makes no claim as to the sensitivity of the receiver, a quick check was made with a calibrated attenuator. The receiver had a sensitivity of 1.5 μV for 20 dB of quieting. Although this is not extreme sensitivity, it is certainly adequate for use in areas where a repeater is operating.

The only deficiency found was the attached antenna, which proved too short for maximum sensitivity. A 6 ft length of wire plugged into the external antenna jack im-

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proved the receiver performance considerably. It may be possible to base-load the existing antenna to improve performance; otherwise, the low-band receiver works fine. If complete coverage of the 6 meter band is desired, the receiver may be slightly retuned with only a small loss of 27 MHz coverage.

The high-band receiver arrived after the tests on the low-band receiver were complete. Upon arrival, the receiver was activated by placing the batteries into the proper holder. The Fort Worth 146.94 MHz repeater was immediately heard with a full-quieting signal. (This repeater is approximately 35 miles from my residence!) Tuning up the band provided many other signals, including taxi, mobile telephone, RCC, paging services, etc. The high-band receiver, incidentally, does not suffer from a too-short antenna. The attached whip can be set for a quarter wavelength for optimum performance. The A-2587 high-band receiver had considerably more audio output than the low-band version. Thus, the receiver did not act as if it had a built-in squelch circuit. However, the background noise is not objectionable. Since the receiver seemed fairly sensitive, checks were run on it to compare. The sensitivity ranged from 3.0 μV for 20 dB of quieting at the low end to 5.5 μV at the high end. (The usable, or threshold, sensitivity is actually much better than the "quieting" sensitivity, and is a more meaningful standard when no squelch is employed.)

Both receivers performed excellently with outside antennas. Because of their small size and low cost ($17.95) the receivers give the amateur portable coverage of the 6 and 2 meter FM frequencies as well as the 11 meter CB and 10 meter amateur frequencies. The construction is excellent. The serious FM'er may want to crystal control the receiver for signal-channel operation. There is sufficient room inside the case for an oscillator circuit.

If the receiver is to be used at a fixed location, it is desirable to obtain the ac adapter ($3.95) which simply plugs into each receiver.

All in all, the Allied A-2586 and A-2587 are well worth the small investment.

...K9STH ■

450 MHZ MIGHTY MITE

E.R. Davisson K9VXL
83 Crestview Drive
Greenwood IN 46142

Have you ever wondered what kind of activity occurs on the ¾ meter band? I suppose you've been curious, like many others, but not sufficiently so to go to the trouble of whipping up a converter or receiver to find out. Well, here is an extremely simple circuit which will allow you to determine if you would like to go to the expense and trouble.

Figure 1 shows the schematic of a simple transistorized superregenerative receiver which will work easily at 420–450 MHz. This circuit provides exceptional sensitivity. If your hearing is good, you may connect a pair of earphones directly to the circuit, although the level of audio is quite low. The more ambitious may, of course, build up a small audio amplifier, borrow one from an old transistor radio, or use an RCA CA3020 integrated circuit audio amplifier.

The transistor used is a relatively new device from Fairchild – a 2N4916, which costs less than a dollar. This transistor is rearing its head as an excellent low-cost device featuring a beta of over 150 at 450 MHz.

No special parts have been used and the only problem area may be the choke in the audio output lead (RFC2). I used the secondary of a driver transformer from an old transistor radio. The value of inductance was around 160 mH. A choke closer to 30 mH would probably be better but doesn't appear to be too critical in this circuit.

Several liberties were taken with this circuit that may or may not appeal to you. Since I was interested in only one frequency, a "gimmick" capacitor (twisted leads) was used to tune the circuit to that

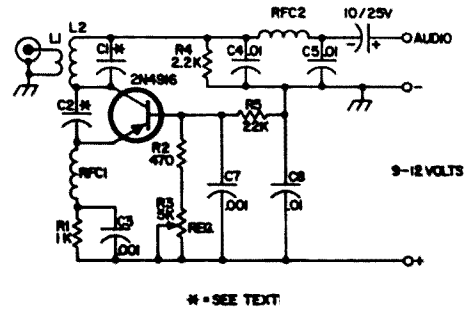


Fig. 1. Schematic diagram of the Mighty Mite *superregenerative receiver for the ¾ meter band.*

frequency. This also alleviated the work involved in providing an insulated shaft for a small variable capacitor. Other means are available for tuning this simple circuit, such as by shading L2. This would provide a means of covering a spread of frequencies but would make the receiver more complex mechanically; and since I wanted to keep it simple, no attempts were made along these lines.

Figure 2A shows the foil side of the printed circuit board and 2B shows the component side. The tank coil, L2, was made from printed circuit board and its size and shape is shown in 2C.

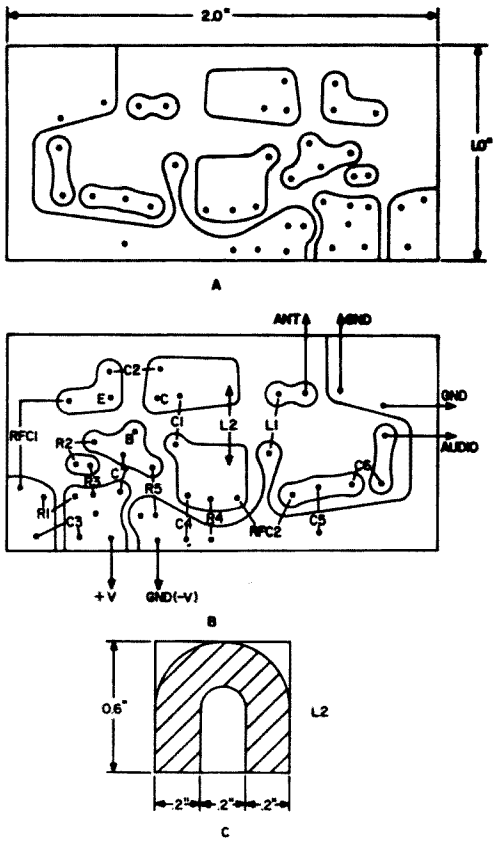


Fig. 2. Suggested PC board layout for the receiver. The foil side is shown in 2A and parts location in 2B. The tank coil (L2) is also made from PC material and shown in 2C.

Again to keep the circuit simple, L1 and L2 are both soldered to the foil side of the board. The more ambitious builder could make slots in his main board to accept L2, so that it would be on the parts side of the board. L2 is soldered perpendicular to the main board with the foil side facing L1.

L1 consists of 1½ turns of hookup wire (3/16 in. ID) spaced approximately ¼ in. from L2 and parallel with it.

C1 is a gimmick capacitor made from two ¾ in. lengths of hookup wire and twisted together. This provides sufficient capacity for oscillation, but is still small enough not to lower the frequency of the tank too far.

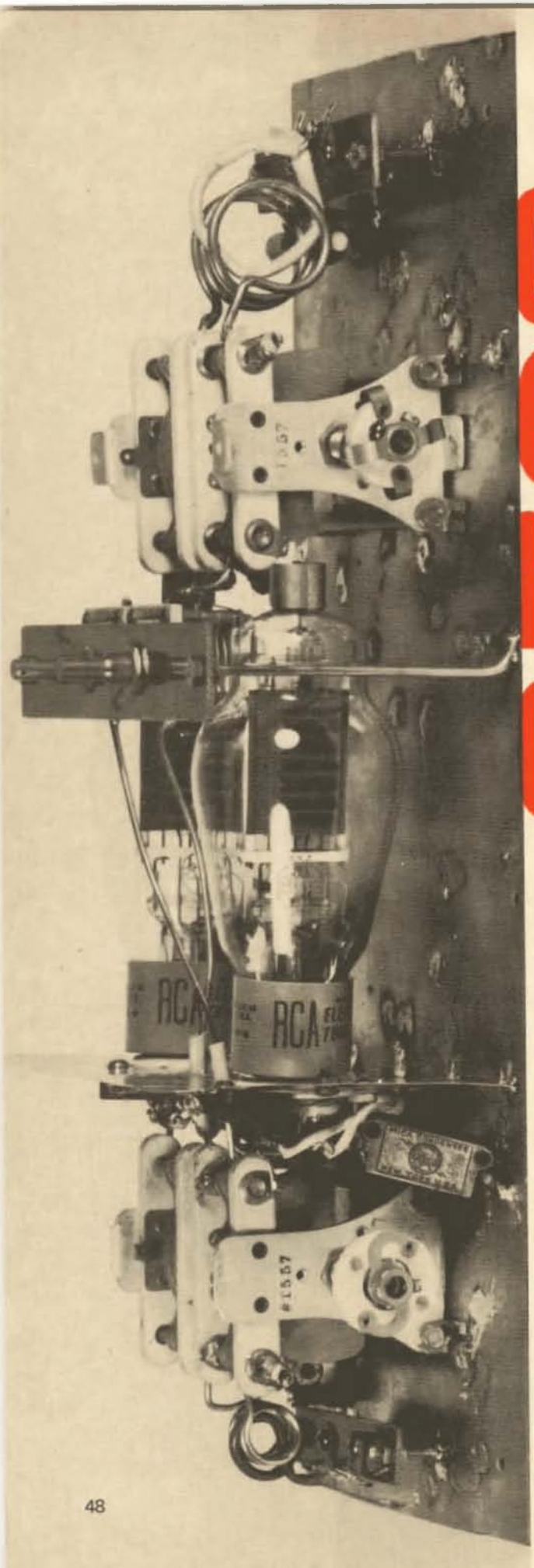
As mentioned previously, C2 is also a gimmick capacitor, only in this case it consisted of two 3½ in. lengths of hookup wire twisted to achieve the frequency of interest. If you take this approach, you might try shorter lengths (such as ½ in.) and try various fixed capacitors, starting at about 1 pF. The total capacity required depends on several items such as output capacity of the transistor used, feedback capacity, and closeness of L2 to the box used to mount the circuit board. In my case, no box was used, so this factor hasn't entered into the design as yet. If you do place this circuit in a box, just remember to make the box as large as possible to keep the sides away from L2.

RFC1 consists of 4½ turns of 16 AWG enamel wire wound on a ¼ in. slug using an AM oscillator coil from an old transistor radio.

After the circuit is built, connect a pair of earphones or an audio amplifier and apply power. If no hiss is heard, slowly adjust the potentiometer until the hiss is heard. The most sensitive position is where oscillations just occur. Try adjusting the spacing of L1 and L2 for sensitivity as well. On my version, a 10 μV signal could be easily detected with L1 about a foot away, so no trouble should be experienced in detecting a signal.

Due to the small size and relative ease of construction, this circuit could lend itself to a 432 MHz transceiver walkie-talkie.

Although this circuit won't give you the results of a multistage converter, at least you can now check to see what's happening with the ATV boys inexpensively and decide whether or not you want to spend more time and money to build something better. . . . K9VXL ■



Bill Hoisington K1CLL
Far Over Farm
Peterborough NH 03458

CHEAPIE 6-METER HALF-GALLON

It works out to $12.50 a quart, and features low-cost tubes, no screen voltage, no bias voltage, no blower.

This article describes a final rf amplifier for 6 meters that will put *out* nearly 400 watts on CW or FM telephony (or a good quarter kilowatt *out* on AM phone). In case you or your buddy haven't a pair of 811As lying around, you can buy them new for only $7.75 each. With only two of these tubes, a couple of two-gang balanced capacitors, a few knobs and jacks, and you're on the air. And it can't cost you over $25. For the amplifier, that is. Of course, if you don't have a husky power supply lying around the costs will start to mount a little.

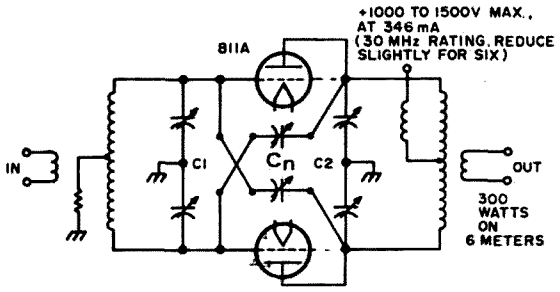


Fig. 1. There's nothing complicated about the half-gallon 6 meter rig as this simplified circuit diagram shows. Put 1000V on the centertap of the tank circuit and she'll draw almost 350 mA at resonance.

The Main Idea

Filling a "one-of-a-kind" contract recently involving construction of a "radio frequency power supply" which called for 5 kV (yes, five thousand volts) at 70 MHz to be used in ionization work, several things came to my mind for amateur homebrew work. Ruggedness, simplicity, smooth tuning, and low cost were among these thoughts, and when I finished, it looked and acted like something of considerable interest for 6 meter hams.

A lot of fine tubes have come out since the 811As appeared some 25 years ago; but which among them will give you nearly 400 watts of FM output for $15 a pair, *new*? Also, without screen voltage, bias, blower, or screen modulation?

As just one example of these hard-to-beat tubes still being used after 25 years, see the "1 kW Economy Linear Amplifier" in the Radio Handbook (Editors and Engineers, Ltd., Indianapolis, Ind.); it has four 811As in parallel.

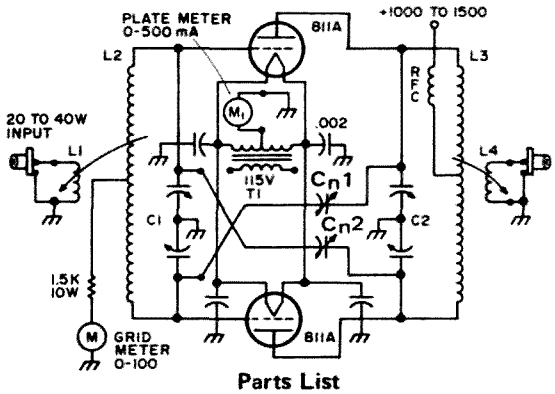
The Circuit

Figure 1 shows how standard and simplified the circuit is. Just take a few precautions as noted in this article, and refer to Fig. 2 for details. One of the advantages of push-pull circuitry concerns the almost complete absence of bypassing requirements (just C3, 4, 5, and 6 on the filament leads). You can bypass the grid and plate return but if L2 and L3 are really centertapped there will be no rf on those leads anyway.

Be sure to keep your fingers away when operating. Remember, they only use 1900V even at Sing Sing!

Neutralization

These 811A tubes are "old-fashioned" triodes but I notice a lot of circuits using them in the latest handbooks. They do require proper neutralization to work good as trouble-free amplifiers at 50 MHz – not critical though, just the proper kind. Since these are "zero-bias" tubes, you can apply 500 to 1000 volts on the plates with no external bias needed and, if not yet neutralized, and L2 and L3 are anywhere near in tune, they will take off and oscillate in great style with several hundred milliamps on the plate meter. This you *don't* want; so, using considerable care and a long, insulated handle, vary neutralizing capacitors C_n1 and C_n2 so that no oscillations occur when L2 and L3 are resonated back and forth across the band. The proper neutralizing capacity is not hard to find, but be sure and rock C1 and C2 *all* over the 6 meter band while adjusting the C_n capacitors. The grid-to-plate capacitance C_{gp} for the 811A is listed as 5.4 pF. I used high-voltage 10 pF capacitors, variable – and sure enough, the dial knobs (which are handy for logging the correct spot for neutralization) ended up near the middle of these scales. Once neutralized, the rig can tune all over the 6 meter band so smooth it seems like magic.



Parts List

C1, C2	Bud 1557, spaced 3/32 in.
C_n	Bud, 6-plate (=10 pF)
T1	6V CT at 10A
C3, C4, C5, C6	.002, 1 kV
L1	1 or 2 turns coupled into L2
L2	6 turns (14 AWG), ¾ in. O.D.
L3	1/8 in. copper tube, 1½ in. O.D., 6 turns
L4	1 or 2 turns link (10 or 12 AWG)

Fig. 2. This complete schematic shows all the details for constructing the final, and gives the information necessary to include proper metering.

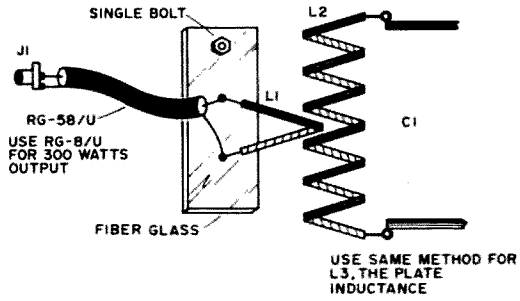


Fig. 3. An effective semifixed link coupling method can be obtained with the link mounted on a pivotable piece of fiber glass.

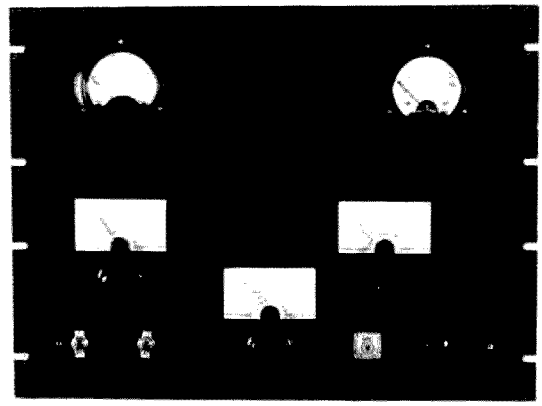


Fig. 4. This photo shows how a complete high-powered transmitter can be obtained using the simple two-triode final.

Layout

Being a fanatic about copper-clad Bakelite (or fiber glass if you're fussy), for baseboard use in experimental work with transistors, I tried one here and the results were equally good. The lead photo shows the layout used, which works fine, either by itself or bolted on a chassis when finished and in a cabinet with dials, input and output jacks, etc. Be sure and use short copper leads for all the rf connectors – especially for the neutralizing circuits and plate tuning components C2 and L3.

Actually, with push-pull circuitry you hardly need a metallic baseboard, but it does allow for easy construction and grounding. And when finished you can bolt it down onto a chassis without change in its operation.

The two flexible couplings on the variable capacitor shafts can be seen in the lead photo. These allow easy placement of the shafts into the back of the Millen dials and take any strain out of misalignment.

Filament Leads

I used 10-gage here because I like plenty of voltage on the filaments. Be sure to mount T1, which should have at least a 10A current rating, as close as possible to the sockets. Each 811A draws 4A, which is one of the reasons they work so well. There is nothing like plenty of electron emission for action! You can even light a 20W bulb at J2 just from electrons going over to the plate through the grid with the B+ lead *open!* You'll also find up to –400V at that point, due to those same electrons landing there.

When you do apply the regular dc plate voltage of some 1000 to 1200V a 200W bulb should light up at J2, but good.

Link Coupling

As usual, with good tuned circuits, not much coupling is needed. One or two turns about halfway in will do the job when loaded into a good tuned-up beam antenna. Both the C1–L2 and the C2–L3 circuits handle very well, with no jumps or odd spots. You will find that overcoupling to L2 shows up with two-peak tuning. Move L1 further out of L2 and good single-peak smooth tuning will be restored. And, once again, be sure and keep your cotton-pickin' fingers off those coils. We don't like to lose readers.

Semifixed coupling links can be used, as shown in Fig. 3. The two terminals can be mounted on a movable piece of linen-based or fiber glass insulating sheet, and fastened with a single bolt to the baseboard for easy adjustment in and out of tuned circuits L2 and L3.

The lead photo shows two bolts for mounting L1 and L4. Suit yourself on that. L4 should use fiber glass insulating tubing, or air spacing. Don't forget there's plenty of fire in L3! Adjust rf output link L4 for a slight dip in plate current at resonance, which should coincide with maximum rf output. If you apply the old-fashioned pencil test to L3 when unloaded, be sure to fasten the pencil to a long wooden handle first. You're dealing with over half a horsepower there! The photo of Fig. 4 shows the front panel used on my job. The

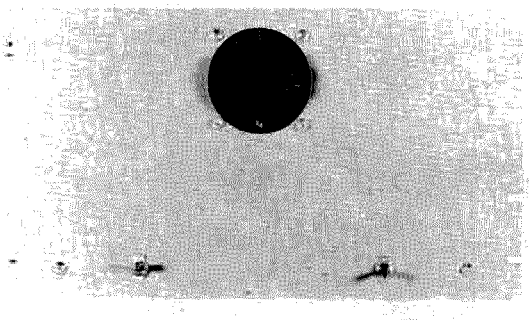


Fig. 5. A Powerstat control on the power supply for the author's rig permits variable voltage delivery from 0 to 1.2 kV.

three Millen dials are used for logging purposes; two of them tune the grid and plate, and the third is for the 70 to 80 MHz oscillator (which, of course, is unnecessary for a straight rf amplifier as described in this article).

Power Supply

Inasmuch as the 811As are 25 years old, I had to dig way back into the cellar to come up with a collection of power transformers, chokes, 866 rectifiers, etc. dating from my 2 meter kilowatt days in the 1946–1949 era. Most of these items have *increased* in value during this time, and they still did a very good job in delivering some 400 watts for the 811As. All you need, basically, is the type 21 Powerstat knob and two toggle switches on the front panel, as shown in the photo of Fig. 5. The Powerstat controls the 0–1.2 kV of the high voltage supply.

If you need to build such a high voltage supply you will have to dig quite a bit through handbooks and mail order catalogs. RCA's invaluable "Transistor, Thyristor, and Diode Manual" is the best help I found.

In the bridge rectifier department, the RCA manual has the "direct replacement for 866 rectifier tubes" in the CR 275 stack, and going back to the Allied catalog you can find its price, which is $22. Or you can string your own diodes together if you want some savings here.

There is a lot of talk in some handbooks about "TV replacement transformers" for use in HV supplies and with the silicon rectifier stack in mind I spent quite a bit more time browsing through the catalogs, again with only medium results. Prices for anything approaching 500W run from a low of $18 to up around $50 for transformers that will give 1500V at 400 to 500 mA. Most manufacturers seem unable to decide on what they do want to offer to customers. Guess I'll have to make an investigation into this matter.

The New Look In Power Supplies

This trend seems to me a mixture of striving for less weight, size, and cost, and at the same time trying to keep "within reason" on the side of reliability and safety. You will have to be your own judge as to the results.

For example, voltage doublers are used to get 2 kV from a 1 kV transformer and you are flatly invited to "try the transformer out and see if the center windings to core insulation breaks down" under the not-designed-for high voltage. At least you are warned! Further, six electrolytic capacitors are strung in series to make up a 2.5 kV capacitor, and the bleeder resistors are composed of the series balancing resistors used across each capacitor in this lethal device. This one can really buy the farm for you with its *10-second* discharge time! Once again, however, you are warned about it.

Modulation

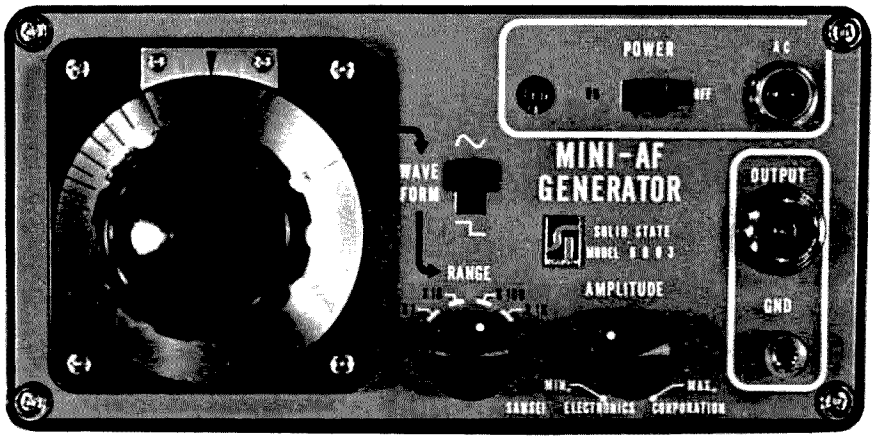
The amplifier shown here can be set up for any of four modulation methods: AM, linear, FM, and SSB. There aren't any screens to worry about and the tubes are zero bias, so it's easy to plan for. Once again, suit yourself on the mode used. Oh yes, it works great on CW also.

Homebrew Power Considerations

As a parting comment, I would say that this whole question of rf power, dc power, and cost to produce them needs looking into. Even more so on 2 meters because of the tubes, the 811As, not being recommended on 144 MHz. There is a tremendous shortage of low-cost, high power triodes for 2 meters! The 4X250s work good and put out real fire, but you start in with $35 and then have to set up a continuous blower and "chimney," a fancy socket, a screen supply, and a bias supply.

...K1CLL ■

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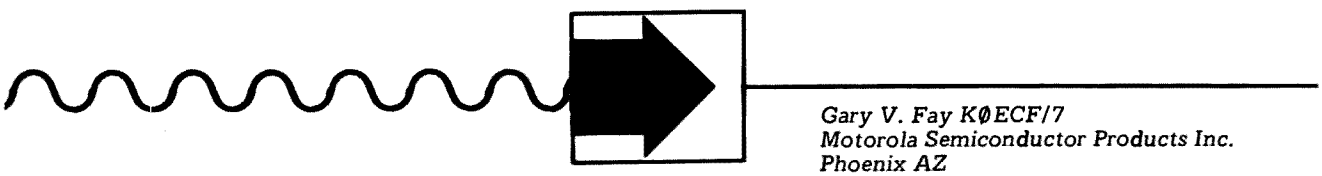
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Gary V. Fay KØECF/7
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Phoenix AZ

Introduction

The function of a dc voltage regulator is to maintain a ripple-free output voltage that remains constant in value, independent of changes in input voltage, load impedance, and temperature. A complex circuit must be used in order to construct a regulator that provides excellent regulation, fast response time, low output ripple, low output impedance, transient-free output, remote voltage sensing, and current limiting. Also, the number of components necessary makes the constructed circuit occupy a relatively large volume if discrete components are used. However, a complex regulator exhibiting good regulation can be constructed as an inexpensive integrated circuit and assembled into a package that occupies a very small space. The Motorola MC1460R monolithic voltage regulator is such a circuit; it is packaged in a single 9-pin TO-66 case, yet can supply an output current of 500 mA with no external semiconductors. This device can reduce the parts count and the volume required for a regulator while maintaining excellent operating characteristics and low cost ($5.25 to $8.25).

The MC1460R can be combined with a small etched circuit board to form a complete, well regulated power supply that can be built in a space not much larger than that required for the power transformer and filter alone. The MCR1460R is designed for input voltages up to 20V; for higher voltages, the MC1461R is identical except that it is useful up to 35V.

Circuit Operation

The MC1460R is basically a series-pass regulator with access to the internal amplifiers. A discrete representation of the MC1460R circuit is shown in Fig. 1, with a complete regulating circuit shown in Fig.2. The series-pass transistor is the output device of a Darlington circuit driven by the control differential amplifier. The dc refer-

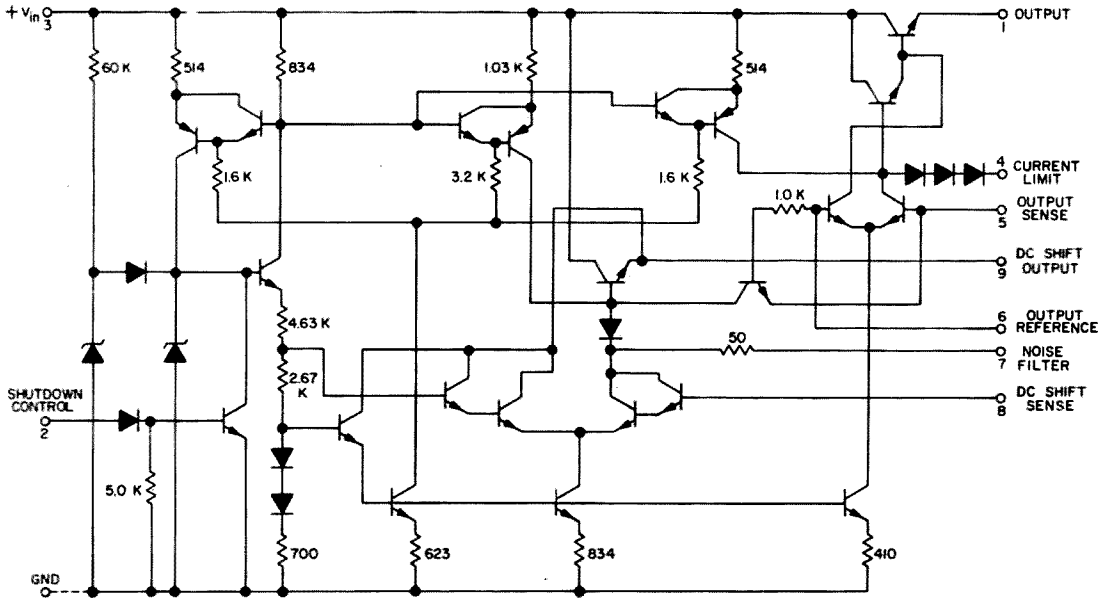
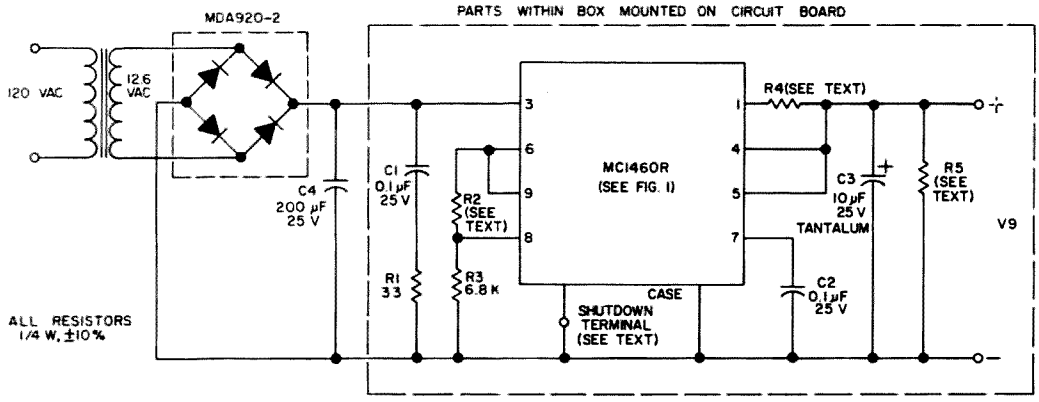


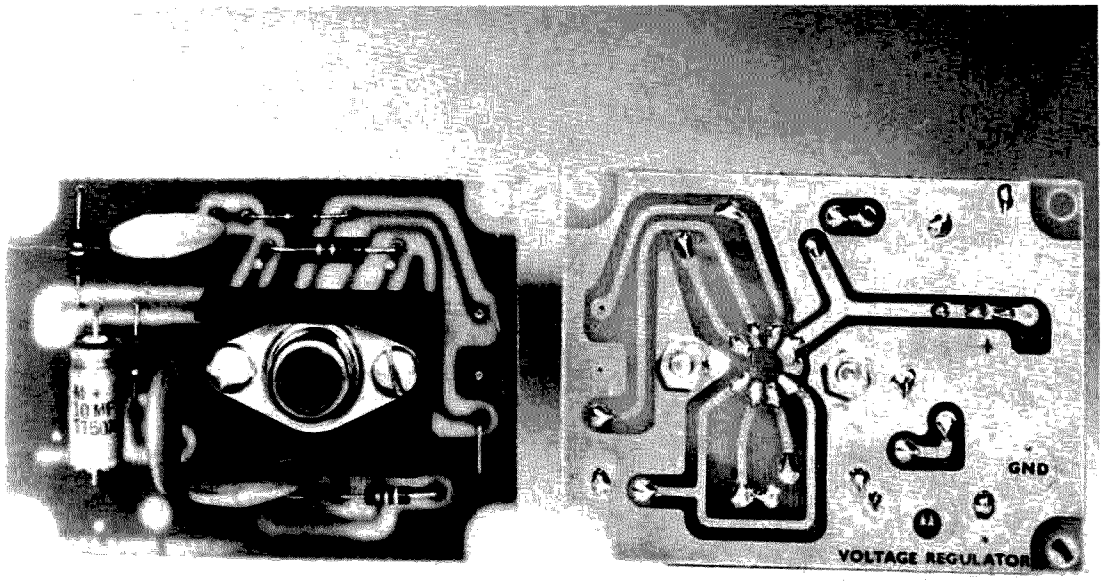
Fig. 1 Schematic of MC1460R integrated-circuit regulator.

ence to the control differential amplifier is provided by an internal series regulator. The reference input to the internal regulator is derived from a zener which is buffered by a transistor amplifier. This voltage is divided by a series resistor–diode string. The output voltage of the internal regulator, which appears at pin 9, is determined by resistors R2 and R3 (Fig.2), connected between pins 9 and 8, and pin 8 and ground. Pin 9 is then connected to pin 6 to provide a reference to the control differential amplifier. The other input to the control differential amplifier (pin 5) is tied directly to the output. Thus the main control amplifier is operated with unity gain to provide optimum ac and dc performance and the output voltage of the main regulator is equal to that of the internal regulator.

By connecting a resistor from pin 1 to pin 4 (in series with the load), the output current can be sensed and limited. This occurs when the voltage across R4 is large enough to forward-bias the internal diode string. Since two of the diodes compensate for the base–emitter drops of the output transistors, a voltage equal to one diode drop is sufficient for this to occur. When this happens, base current drive to the output Darlington transistors is diverted through the diodes. An equilibrium is reached which provides just enough base current to forward bias the diode string. Due to the large amount of feedback used in the main control amplifier, the tran-

Fig. 2 Regulated power supply using intergrated circuit voltage regulator.





Front and back views of etchedcircuit board used for IC regulator.

sition from voltage regulation to current limitation is very sharp.

Construction

All of the parts for the regulator in Fig. 2 except the power transformer, bridge rectifier, and filter capacitor can be placed on the etched circuit board shown in Fig.3.

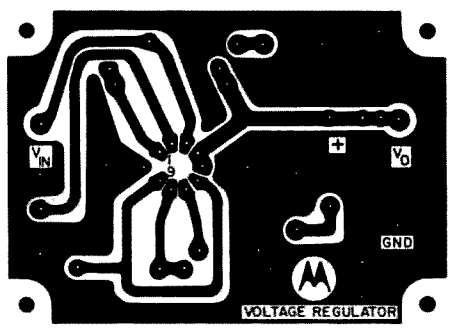


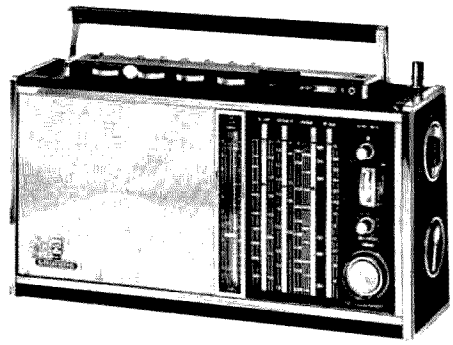
Fig. 3. Etched-circuit board used for regulator. Available for $1.25 from Project Supply Co., P.O. Box 555, Tempe AZ 85281.

The board is available for $1.25 from Project Supply Co., P.O. Box 555, Tempe AZ 85821. This provides a convenient way to construct an operating circuit and also controls the lead dress used in construction. This will minimize possible parasitic oscillations that may occur due to phase shift from reactive elements. The high gain and wide frequency response of the monolithic regulator makes this a problem at frequencies up to 60 MHz, so even stray wiring capacitance can cause oscillation. Thus, high frequency construction practices are necessary to prevent oscillation possibilities.

The MC1460R must be mounted on a heatsink for high power dissipation. In this case, the passive components are mounted on the copper side of the board. The heatsink must be spaced away from the board to prevent shorting to the leads of the components which project through the board. A suitable sink is the Thermalloy 6168. Silicone grease should be used between the IC and the heatsink for best heat dissipation, and insulation should be used on all leads to prevent shorting to the heatsink.

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Bandspread	28.3–29.8	Longwave
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	13.8–14.5	
(includes CHU)	7.0–7.35	Broadcast Band
(SW Broadcast)	5.95–6.25	510–1650 kHz
	3.5–3.8	
	1.7–2.0	HiFi FM (Wideband)
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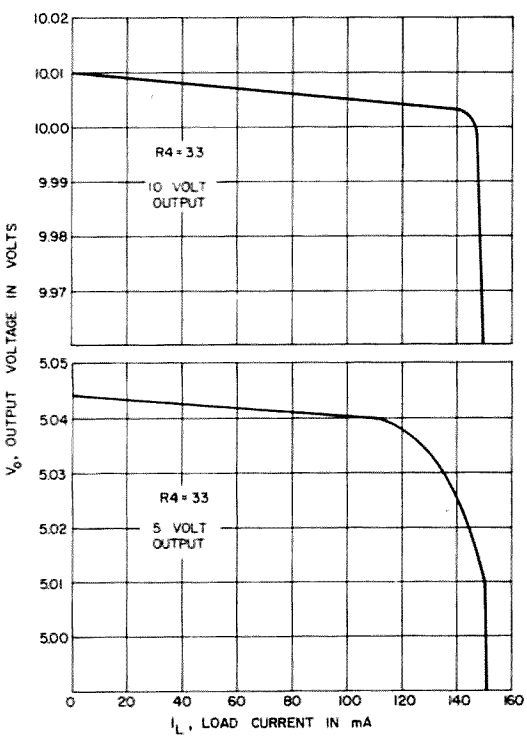


Fig. 4. Output voltage vs load current at 20V input.

Output Regulation

The curves of Fig.4 show that excellent voltage or current regulation can be obtained with the assembled circuit. No heatsink was used for these curves. For the regulator used, the output voltage varied only 2 mV for the 5V setting from 1 to 120 mA of load current, which corresponds to a load regulation of 0.04%. Less than 10 mV of change in the output voltage could be observed for the 10V output with up to 130 mA output current, which is less than 0.1% load regulation. This performance results from the combined effects of output impedance and junction heating. The effect of output impedance tends to make the output voltage fall while junction heating effects from increasing load current tend to make the output voltage rise.

The high gain of the MC1460R makes the transition region between the voltage- and current-regulating modes very small and the current-limiting region very sharp. Thus, from 9.99 to 0V output, the current

varies by only 3 mA from its limiting value of 150 mA.

Input Regulation

The dc input regulation characteristics are shown in Fig. 5 for load currents of 1, 50, and 100 mA for both 10 and 5V output. Again junction heating effects are present and result in the 0.01%/V regulation shown. The ac input regulation, although not shown, is typically 0.003%/V.

The minimum input–output voltage differential for the MC1460 is 3V. Thus, when the output is set for 10V, the required input is 10V plus 3.0V, or 13.0V. For 5V output, the minimum input–output voltage requirement would give an input voltage of 8.0V. However, the minimum input voltage for proper operation of the MC1460R is 8.5V, and this would be the required input voltage for anything less than 5.5V output.

Power Dissipation Limitations

When the input voltage is at the maximum rated input of 20V and the output is shorted, the regulator must withstand this voltage and supply the short-circuit current I_{SC}, which is itself set by R4 according to the following formula:

$$R4 = \frac{0.5V}{\text{max output current}}$$

For example, with an R4 of 3.3Ω, I_{SC} will be 150 mA. For 20V in, 0V out, this gives a power dissipation of 3W. Therefore, the package would have to be mounted on a heatsink. The amount of heatsink area required depends on the ambient temperature and in this example would have to be enough to keep the case below a temperature of 127°C.

Output Voltage Adjustment

The output voltage is set by the values of resistors R2 and R3. The voltage at pin 8 is typically 3.5V. To minimize the loading effect due to base current on the voltage at pin 8, a current of about 0.5 mA is required through resistor R3; thus, its value should be about 6.8 kΩ. Although a low temperature coefficient is not required for these resistors, the *same* temperature coefficient is necessary to keep the ratio independent of temperature so that the output voltage is constant over temperature.

Shutdown Control

Both the MC1460R and the load current can be turned off (or "shut down") via the shutdown control at pin 2. Under this condition the output voltage drops to almost zero, allowing only a few microamperes to pass through the load. The shutdown control voltage can be provided by any saturated logic such as DTL, RTL, TTL, etc. If shutdown is not necessary, pin 2 should be grounded to prevent spurious signals and inadvertent connections from shutting down the regulator.

Conclusion

The basic MC1460R integrated circuit voltage regulator is seen to be a useful component which operates with a minimum of external components and without the need for external semiconductors. The outstanding performance achieved by the regulator can be obtained at a relatively low cost.

...KØECF/7 ■

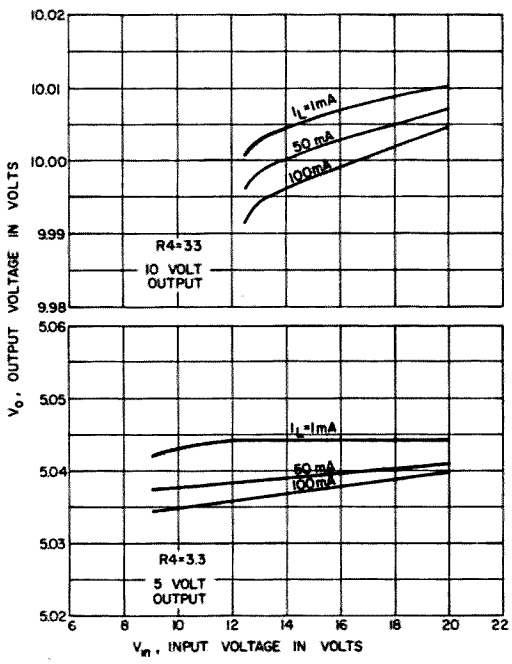
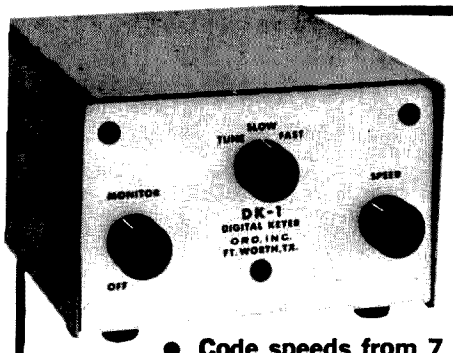


Fig. 5. Output voltage vs input voltage at various load currents.



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These examples illustrate the minimum hand motion required. The dot and dash keys may be closed or released in the order indicated within microseconds of each other.
"A"—Close dot-dash key. During the dot or dash, release dot-dash key.
"R"—Close dot-dash key. During the dash or second dot, release dash-dot key.
"P"—Close dot-dash key. During the second dash or dot, release dash-dot key.
"L"—Close dot key. During the first dot, flick the dash key. Release dot key during the last dot.
"B"—Close dash-dot key. Release dash key at any time during the three dots and dot key during the last dot; or, release dash-dot key during the last dot.
"Double Dash"—close dash-dot key. Release dot-dash key during the last dot or dash.

Note that in the above examples, only one depress-release cycle of the dot and dash keys is required. All letters, numbers and punctuation marks may be generated using variations of this technique.

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A Soldering Gun Tip...

Steve Harrison WB6PKA
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Palos Verdes Peninsula CA 90274

73 Magazine carried a little tip in the July 1969 issue for prolonging the life of the standard soldering gun tip (no pun intended). The method described involved heating a regular copper tip with a propane torch and tinning the copper tip with silver solder. This method is good, but it seems to be a heck of a lot of work to prolong the life of a little piece of copper wire. Most of us have found that a little piece of 14-gage common copper housewire will replace the half-dollar tip for the guns that are bought. Why not go one step further and, instead of using copper wire, use the silver-plated grid tuning lines from the final of the common surplus 522 VHF transceiver? Many of us experimenters have such units kicking around in the basement that have been cannibalized for parts, and if the grid lines are still there, they can be put to immediate and good use.

Other sources of silver-plated wire probably come to your mind as you think of the 522, and as long as the wire will fit into the gun, the wire will work. If you will just take it easy and let your gun cool off a little now and then, the gun just *might* last as long as your new tip!

. . . WB6PKA ■

Reference:

Make Your Soldering Gun Tip Last Longer, by William P. Turner, WAØABI, 73 Mag, July 1969, Page 127.

Latham Island

Garth Hamilton 5H3LV
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Toronto 290 Canada

As some of the world's DX population know there have been many attempts to get permission to operate from Zanzibar and its islands. Zanzibar is composed of Latham Is. or Fungu Kizimkazi, a bird sanctuary southeast of the main island of Zanzibar and Pemba Island to the north-northeast of the main island of Zanzibar; also included are the islands of the Zanzibar Channel from Pemba in the north to Kizimkazi or Latham in the south.

There has been a long pursuit for permission to operate, which started in January 1969 and proved fruitless as no replies or acknowledgment to any correspondence were ever received. In Sept. 1969 I approached Bill 5H3KJ, on the matter as we had been friends for aboul a year and I had by this time also learned the intricacies of procedure of the country and its people. So, after several discussions I decided to write to the office of the first vice president which is also the office of the president of Zanzibar. (To be noted: Zanzibar is completely autonomous within the union of Tanzania.) Once again the long wait began. Early in 1970 I learned that people were asking friends about me so I figured another security check was being made similar to the to the initial one upon my first request to operate in Tanzania in July 1968. It was this which prompted me to start things moving again, knowing that in six to eight weeks I would have an answer. So Bill and I started planning the final details in late January, projecting the operation for the last weekend in February. I chose Latham or Kizimkazi after research showed it to be a bird sanctuary (with no habitation, which

meant no customs and immigration formalities). Bill made arrangements for a friend to use his boat and service; as skipper in return for cost and fuel for the boat – he also arranged the rental of the Honda E300 and E800 generators which we used. Also from Bill came the mast stays, and stacks for the TA33jr. As my transceiver was in poor shape due to weak tubes, I started scrounging for new ones. K3RLY supplied the tubes and W5KUC provided the vertical, with WA5REU paying the air freight out. So by mid-February everything was moving smoothly. The tubes arrived and G3RIR helped Bill and I get his rig realigned along with our own as all three rigs would be going on the trip (but not G3RIR, as he hadn't a license yet).

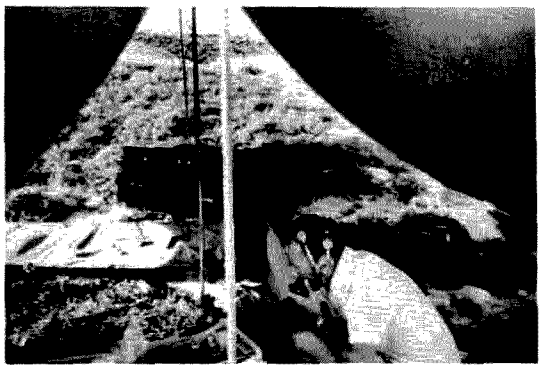
On schedule nine days before we were to go came the long-awaited letter giving permission to operate from Zanzibar *provided the East African Posts and Telecoms had licensed us.* I went to Nairobi where 5Z4KL and LW had revived the East African Radio Society's TA33jr from a pile of junk into a serviceable antenna once again. Equipment used and from whom supplied was as follows: W5KUC – 14 AVQ; RSEA – TA3jr: G3RIR – HW100; 5H3KJ – SB100, SB200 generators, masts, and gasoline; and 5H3LV modified HW100, provided camping equipment, packing containers, and misc.

Thanks to our QSL managers, W7VRO for 5H3KJ, CanaD-X VE3ODX for 5H3LV for their continued help in this field. The CanaD-X group are partly if not wholly accredited with getting my HW100 and myself on the air on SSB during my leave



Garth (5H3LV) and Bill (5H3KJ) pose in the uniform of the day of Fungu Kizimkazi, a Zanzibar bird sanctuary isle northeast of the main island, the site of their DXpedition.

DXpedition



Bill's first attempt to operate 10 and 15 meters had to be abandoned because of watersoaked components in the rig.

period in Canada last May. Such hams as VE3PQ (exVE3CKW), VE3DLC, VE3ACD, VE3NE, VE3HJ, and many others across Canada, whose calls I cannot recall, became responsible indirectly for this operation from Zanzibar. Also W5RBO for his encouragement and financial support.

Now to the more active part which everyone witnessed. We left Bill's at about 9:30 a.m. with all the gear on the VW roof and back seat for the customs jetty where we were to depart at 0700 (GMT). However, the boat was not ready and it was not until 10:45 a.m. that we got the boat to the wharf and loaded it. By 0800 we were under way in the harbor and our passage proved very quiet and comfortable on a smooth sea.

It became apparent early that we were not making the speed the boat was capable of and were informed that this was due to the weight we were carrying. We arrived at Kizimkazi at 1200 already two hours late.

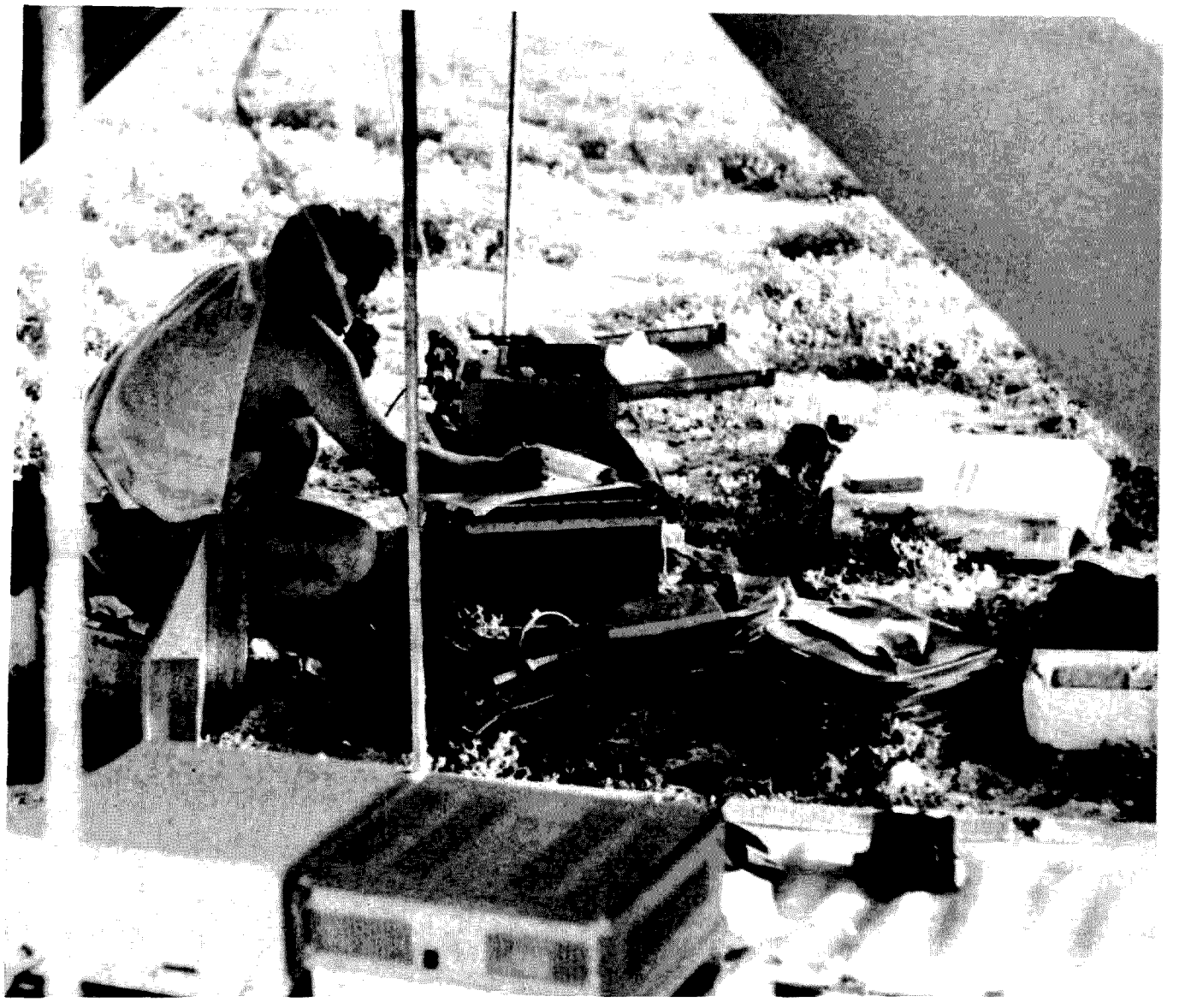


With the large number of birds on the island, the tent served as protection from more than merely falling rain.



By 1320 we had all equipment ashore. One minor mishap occurred during the first landing when Bill and I were not quick enough in getting the boat out of the surf; one wave broke over our stern, getting one packing box wet. On preliminary inspection the equipment seemed to have escaped harm; however, later we learned that the circuit boards in my modified HW100 had gotten wet. This put our second split-frequency rig out of commission before we started.

By 1400 the beam was up and Bill was arranging the operating positions while I got the vertical up. At about 1430 we had a quick snack and Bill came on the air on 15 meters. This is where I discovered the water! When I got the other HW100 out and found the power cord from the dry rig wouldn't fit the water-logged one and vice



Garth roughs it by setting up the station outdoors.

versa, we were in trouble. I informed Bill who QSY'd to 20m at 1450, and I started splicing power cables to get the station going. By 1600 I was ready and Bill went up to 15m again; and I finally started operating transceive on 20m.

It was bad right from the start as I could hear stations from every continent calling and not pausing long enough to hear who I had replied to. I was finally forced to work from lists with stations on each continent taking a list to hold for me. I started with the W6s with 5Z4KL serving as "list master." A DJ started a list for Europe, but by 1630 I closed down. I checked the frequency again 45 minutes later – the racket was still over the S9 mark. How they expected to work me under those conditions I don't know.

I believe the action of closing the station may have helped Bill out when he later volunteered to reopen on 15m at 1800, at which time I started operating split-frequency on 20m and stayed there until the band shut down at 0530. Maybe the fact that the 15m band at this time was not open to so many places at once made it a bit easier for Bill to control the frequency. But his technique of frequently moving and his expert handling of contacts served to prove what a first-class operator he is. Bill operated 15m until 0230 when the band closed an unprecedented 3 hours after that band's longest recorded opening previously in East Africa.

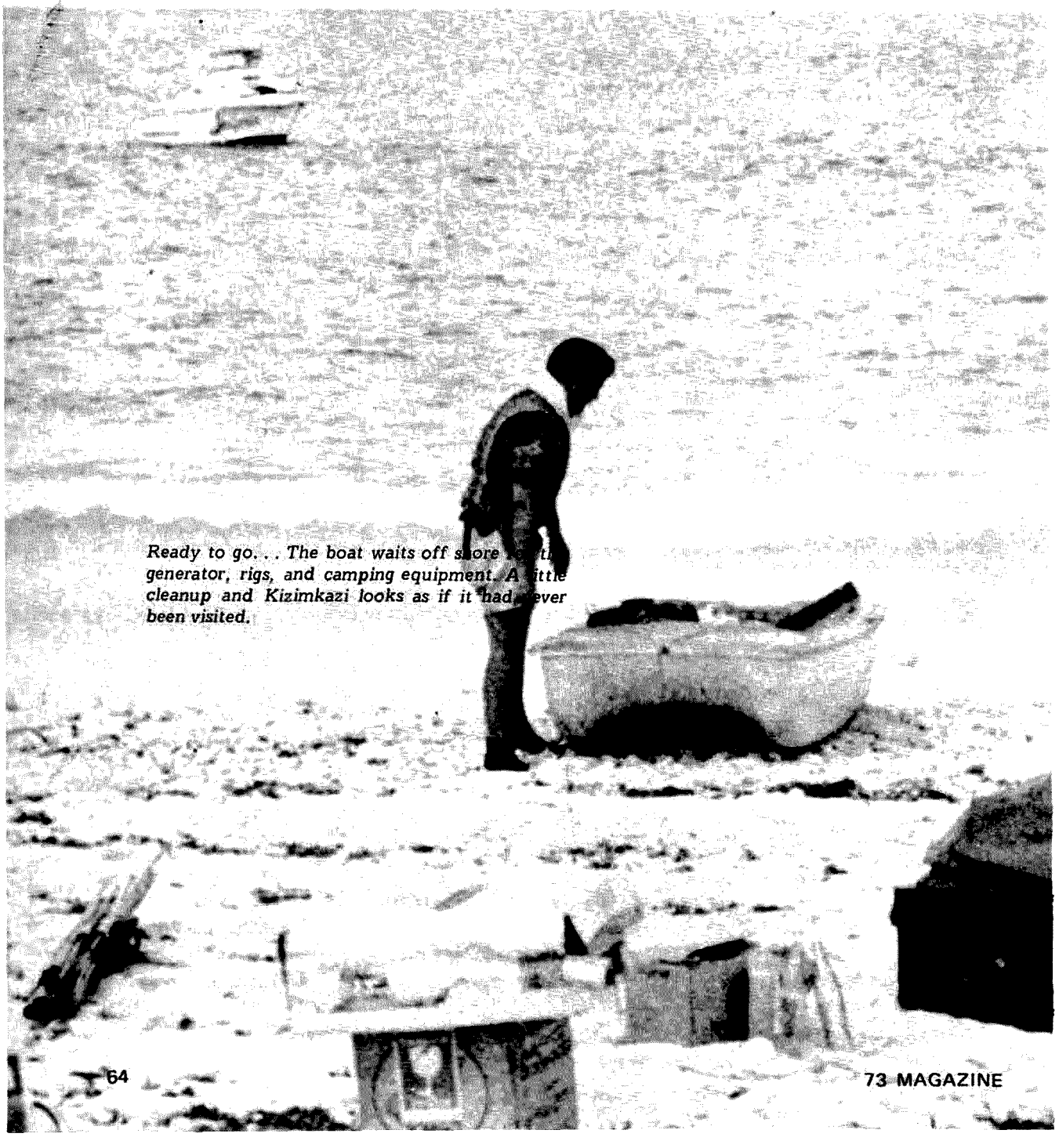
Bill took a nap while I made the final run to the finish. It was interrupted when my generator ran out of petrol at 0530.

A few people felt the brunt of our strife to maintain control of our operating fre-

quencies when they refused to heed warnings about tailending – a deplorable yet increasingly common practice – and calling out of turn. I trust these people now realize that such tactics don't endear them to a DX station and least of all a DXpedition. Some of these practices showed up from stations I least expected to hear them from.

Some very sharp teenage hams using 180W rigs got through using some very diligent operating by listening to ascertain just how much of the band I was spanning in relation to what I said I was covering (which was more by 10 kHz on the top side) and then finding a clear spot to transmit and waiting until I started to span near their frequency. These fellows usually got through within three calls while some of the 2 kW wide-spaced monobanders didn't because they staged a howling contest on the bottom few kHz of the band.

The transceiver operators also had a few tricks up their sleeves. They made short



Ready to go... The boat waits off shore with generator, rigs, and camping equipment. A little cleanup and Kizimkazi looks as if it had never been visited.

calls, gave their reports, and mentioned they were transceive. So I gave them an extra second to find me again before I gave their report.

As some of you may know, Bill (5H3KJ) is now QRT and will be heard again as LA6GF. Bill has been a very active ham with over 270 countries to his credit in four years of operating here. He was first licensed in 1956 as LA5GF. I (5H3LV) have been QRT since May 1 this year, after 10 months activity on SSB, having worked 235 countries. I will reappear as VE3EUP on the bands. There is a chance I'll return to this DX spot for a further two years but that is not definite at this time. Since I am the last remaining DXer from here, I shall look forward to the possibility with the added incentive of being the only authorized operator for Zanzibar at this time. If I should return I'll be looking for a rotator for my station quad and an SB200 to boost the signal some more. I shall also endeavor to have an 18AVQ operating at about 50 ft to see if I can do something with the 40 and 80 meter bands. ... 5H3LV ■



STAFF

STUDY GUIDE FOR YOUR GENERAL CL

PART ONE: A STARTING POINT

Following up the tradition we've established in our two previous study courses on the Advanced Class license and the Extra Class license, we've found that it's now time to tackle the General/Technician classes. Since the technical knowledge required for both the General and the Technician class ticket is the same, only one course is necessary.

In case you missed the earlier courses (and if you did, contact the publisher immediately with cash in order to get the collected and bound versions for your reference shelf), here is how we go about it:

Unlike other "Q&A" publications which provide concise answers to the specific questions which the FCC includes on its published "study list" for each class of amateur license, we try to go *behind* the study-list questions and examine the principles on which each question is based.

This makes it much more difficult to simply memorize our answers before taking the exam, but we believe the advantages outweigh this disadvantage (if it really is one). If you study our courses, you'll find that you can still answer the exam questions even if the Commission throws you a curve (as it has been known to do) and includes questions on the real exam which apparently were not even hinted at on the study list. The memorization method won't let you do this.

Because we go so much deeper than most into the theory behind the questions, we must handle the study list in smaller bites. In the past, we've averaged about 5 questions from the FCC study list each month, and the course lasts for as many months as are necessary to cover the material adequately.

In this course, though, we don't expect to average much more than 3 questions each month – because we cannot expect a student working for his General or Technician ticket to have as much technical

background as would someone already eligible to apply for the Advanced or Extra Class ticket. Some months we may take more, and some months less – it all depends upon the questions, and the amount of background necessary.

In this initial installment, we've got to establish a starting point upon which to build all the rest. We'll do so by discussing the theory behind questions 27, 35, 36, and 37 from the FCC study list.

The questions, as published in FCC Bulletin 1035C, are:

27. Define Ohm's Law. How does it relate to resistive and reactive impedance?
35. How do resistors combine in parallel and in series to give total resistance? Capacitors? Inductors?
36. How does voltage division occur across series connected resistors? Capacitors? Inductors?
37. What does it mean to connect circuit elements in series? In parallel?

ASS LICENSE

As we have done in the previous license study courses, we'll re-phrase these questions into new ones which expand to cover the theory behind the FCC's examples.

Our first question, which is ambitious enough in itself to fill a book (and many have been filled with not-too-informative answers to it), will be "What Are Current and Voltage?" In finding answers to that, we'll endeavor to give an accurate definition of not only current and voltage, but what fields and waves amount to and how electricity is propagated.

And in doing so, we'll follow our long-time rule and ban all higher mathematics. To paraphrase Tom Jefferson et al, we hold this truth to be self-evident: That any concept formed by a human mind can be understood by any other human mind, provided only that the concept is framed in terms of other ideas the student already holds. In other words, you don't have to be a genius to understand the ideas a genius has developed, if we can explain them adequately in simple enough terms. To do so, we must rule out any math more complicated than arithmetic and from time to time a touch of the simpler parts of algebra.

When we complete this seemingly-impossible answer, we'll move on to ask "What About Alternating Current?". This will give us an opportunity to look at different ways of connecting elements in a circuit, as well as at the different types of elements themselves.

Think we can do it? Let's dive in and find out.

What Are Current and Voltage? To find out what current, voltage, and the like are, let's go all the way back to the beginning of man's studies of this strange thing called "electricity."

Since ancient times, men have known that some materials such as amber and later glass have the ability to attract light objects to themselves under some conditions. The magnet's discovery is also lost in the mists of prehistory. But until the middle of the 18th Century, both "electricity" and "magnetism" smacked of magic. Little was really known about either.

In 1800, though, an Italian scientist named Volta invented a chemical cell or "voltaic pile" which provided a constant source of electrical energy. Once a laboratory source of electricity was available, many investigators turned their attention to electricity and magnetism – and during the decade from 1820 to 1830 most of the basic laws of electricity were discovered.

Among these was Oersted's observation, in 1820, that any flow of electricity was accompanied by a magnetic field. This observation led the French physicist Andre Ampere to study the forces which resulted from flowing electricity, and Ampere as a result classified electrical effects into "electrostatic" force and "electrodynamic" motion, which he also called "electric

tension" and "electric current." "Electric tension" (now called voltage, for Volta, in this country, but still called "tension" in Great Britain) is a measure of electrostatic force. Electric current, measured in "amperes" (after Ampere), is a measure of electrodynamic motion.

Michael Faraday discovered, in 1831, that motion of a magnetic field would "induce" a flow of electric current in a stationary conductor. This completed the symmetry of electrical and magnetic effects, but the actual manner in which electricity and magnetism were related remained unknown.

Many ideas were put forth, but none could be proved to actually be true. The most lasting, probably, of these ideas involved the "line of magnetic flux." This "line" survives today as a part of basic theory as taught in engineering courses – but most authorities now believe the line to be imaginary, rather than an actual thing.

Since the work of Oersted, Ampere, and Faraday (as well as others less well-remembered) had made the relationships between electricity and magnetism obvious, many investigators attempted to express the rules of the relationships. None succeeded until James Clerk Maxwell, in 1865, published his "Dynamical Theory of the Electromagnetic Field." While the theory itself has not yet been (and probably cannot ever be) proven beyond doubt, it *has* successfully predicted, and continues to predict, all electromagnetic actions within its intended range, and is today accepted as a true working theory

Maxwell's Equations, which define the theory mathematically, are required knowledge for any electrical engineer, and once they are understood they provide adequate explanation of all electromagnetic effects yet observed.

The actual equations are not simple. Maxwell himself required 20 separate equations in 20 variables to express them. Their reduction by later workers to the four Equations taught today has added a requirement for knowledge of integral calculus, differential equations, and vector analysis, since these were the tools used to reduce the equations.

The theory, taken apart from the Equations, is elegantly simple, though, and not too difficult to understand provided we don't ask a few critical questions which it cannot give us answers for. It begins with a single assumption – that the space around electric or magnetic objects contains (to quote Maxwell) "matter in motion, by which the observed electromagnetic phenomena are produced."

From this assumption, Maxwell went on to define "the electromagnetic field" as being "that part of space which contains and surrounds bodies in electric or magnetic conditions." He was careful to point out that this could be as complete a vacuum as could be obtained anywhere, but that there would always be "enough of matter left to 'receive and transmit the undulations of light and heat."

Because the transmission of light and heat was not greatly changed when transparent objects such as glass were substituted for the best available vacuum, he concluded that the "undulations" must be occurring in some form of matter which was not directly observable. He called this unknown form of matter "an aethereal substance," which later workers shortened to "the aether" or "the ether"; the question whether "the aether" exists is one which Maxwell's theory cannot answer, because the assumption that it *does* exist is the basis on which the theory is founded.

Later experiments by Michelson and Morley cast doubts upon the existence of the aether, and for many years now the label "aether" has been out of style. Today, we know this unknown medium as "the space-time continuum," but for our purposes here the change is more one of name than of basic concept. Therefore we will temporarily ignore the work of Michelson, Morley, and Einstein, and for the moment think only in terms of Maxwell's "aethereal substance." By doing so, we can get an adequate – and accurate – picture of how voltage, current, and charge operate.

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"Now the energy communicated," wrote Maxwell, "must have formerly existed in the moving medium." He based this conclusion on the observed fact that a detectable time delay exists between the energy's departure from its source and its arrival at its destination. He then borrowed knowledge from studies of the familiar motion of objects, to conclude that while the energy was in the unknown medium, it must have been "half in the form of motion of the medium, and half in the form of elastic resilence."

From this chain of reasoning, he drew the conclusion that the parts of the unknown medium "must be so connected that the motion of one part depends somehow upon the motion of all the rest," and at the same time "the connections between the parts must be capable of elastic yielding" of some sort, because otherwise the communication of motion from one part to any other would not require any time – and both heat and light, though fast, do not travel instantaneously.

Maxwell then reworded this conclusion into a description of the significant properties of his unknown aethereal medium; he said that it was "capable of receiving and storing up two kinds of energy, namely, the 'actual' energy depending on the motion of its parts, and 'potential' energy, consisting of the work which the medium will do in recovering from displacement in virtue of its elasticity."

These two kinds of energy, "actual" and "potential," correspond exactly to the "kinetic energy" and "potential energy" of ordinary objects. They also, as it happens, correspond exactly to the "electrodynamic" and the "electrostatic" effects named by Ampere.

The equations Maxwell developed provide the actual descriptions of these properties, based on the observations reported by earlier investigators. Engineers need them. They are not necessary for an understanding of "how" voltage, current, and charge work.

According to the theory as developed by Maxwell, the induction of current in a stationary conductor by a moving magnet, or in a conductor moving past a stationary

magnet, is a result of the same force involved in transmission of motion from one part of the medium to another. It is, then, an effect of "actual" energy as contrasted to "potential" energy.

If the conductor does not form a complete circuit, no current can flow. Instead, a voltage or potential appears across the ends of the circuit. Should the circuit be completed, current will flow and the voltage will vanish – but so long as the circuit remains open, current will be zero and the voltage will be present.

This voltage or potential represents a transformation of energy from its "actual" state of motion into the "potential" state of storage.

This transformation of energy from "actual" to "potential" is a cornerstone of Maxwell's idea, and his summation of it is the feature which gives his theory its great power to explain and predict all electromagnetic effects.

"The propagation," he wrote, referring to the propagation of light and heat through his undefined medium, "consists in the continual transformation of one of these forms of energy into the other, alternately."

That is, he conceived of the transmission of electromagnetic energy as an endless process of transforming energy from a state of motion to a state of storage, and back to motion.

Figure 1 shows how you can illustrate this principle with a row of pennies or other coins, by lining them up in a straight line so that each touches its neighbor on either side. If you strike the penny on one end with another coin, and if the motion of the "striker" coin is in line with the other coins, the penny at the other end will fly off the line but none of those in between will move visibly.

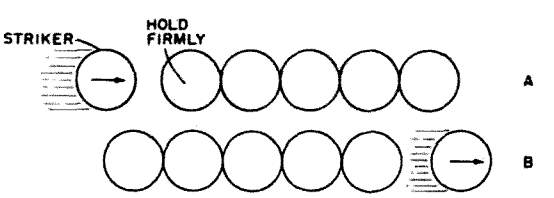


Fig. 1. Simple experiment with rows of coins illustrates motion-compression-motion cycle which is basis of both electric current and magnetic effects. If coins are lined up as shown at A, with one held or clamped firmly, and line is struck end-on by another coin, coin at far end of line will move off of line but those in between will not move visibly. Text explains why.

What actually happens in this demonstration is this: The energy of motion of the "striker" coin compressed the first penny by a microscopic amount at the moment of impact. As soon as the impact force had all been transformed into a compression, then nothing was holding the first penny compressed, so it sprang back into its original shape. This motion of rebound, in its turn, compressed the penny next to it, and so the motion was carried down the line of coins, one penny at a time, by an alternate series of motions and compressions.

Exactly the same sort of thing, said Maxwell, goes on to produce the propagation of electromagnetic energy. And since by his theory every "electric or magnetic body" is surrounded by his aethereal medium, and present theories hold that all physical matter is electric in nature, it follows that electromagnetic energy can be propagated in this matter throughout all parts of space which are occupied by any kind of physical matter.

Actual physical matter divides into two broad classes known as "conductors" and "insulators"; the defining property which separates these classes is that conductors permit the flow of electric current within themselves, and insulators do not.

It is generally believed that the difference depends upon molecular and crystalline structure, and that conductors contain electrons which are free to move anywhere within the boundary of the conductor without restraint, while insulators have few or no "free" electrons. It is important to keep in mind that these "free" electrons which are involved in the flow of electric current are a part of the conducting material, and are *not* associated with the "aethereal substance" which provides a means for propagation of electromagnetic energy.

What happens, according the present theories, is that the energy transformations going on in the "aethereal substance"

impart some of their energy to the free electrons. The exchange is two-way in nature, so that free electrons in motion lose some of their energy to the unknown medium. We say that such energy is "lost by radiation" and the whole point of a radio transmitter is to "lose" as much energy as possible by radiation, in order to communicate over long distances.

When the free electrons of a conductor receive excess energy, they move in the direction indicated by the energy. Their motion is, as we shall soon see, by definition the flow of an electric current.

If the conductor forms a complete circuit, the free electrons can move indefinitely in the same direction as long as they maintain their energy. The energy is gradually lost, however, by being released back to "the electromagnetic field" and by collision with "bound" electrons and other atomic particles in the conductor.

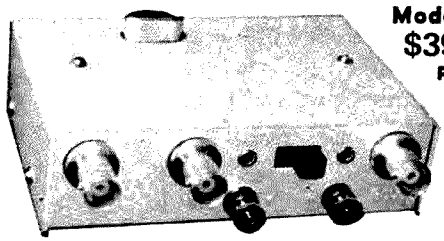
When a free electron approaches a bound electron, the bound electron is repelled and attempts to get out of the way. The bound electron, though, is an integral part of an atom, which in its turn is fixed into place in a molecule, and it cannot get out of the way unless the whole molecule moves. To move a molecule takes energy, and molecular motion is also known by the more common name "heat."

This transformation of electrical energy of motion into the molecular motion of heat is called "resistance," and all normal conductors have resistance in varying amounts.

If the circuit is not complete, the electrons can move only a limited distance before they reach a boundary which stops their motion. The motion-compression-motion cycles must then halt in a state of compression or "storage."

The "storage" of energy occurs not in the conductor, but in the insulating medium which keeps the circuit open. Although the electron theory of matter was still several decades in the future when Maxwell developed his theory of fields, he considered that "the electricity" in each molecule of the insulator was forced to one side or "displaced" from its normal position by the "potential" energy, and re-

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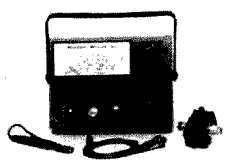
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mained there until either the removal of the potential energy, or the completion of a conducting circuit around the insulator, permitted the displaced electricity to resume its normal position.

This "displacement" of the internal structure of an insulator under pressure of applied voltage is what we now call "charge." Since the electron theory was developed, we consider that the displacement occurs by a bunching of the electrons within the insulating material, and, if necessary, a physical distortion of the material's molecules to align most of the electrons on one side.

We measure "charge" by a unit called the "coulomb," which is approximately equal to the displacement of 6,280,000,000,000,000,000 electrons. An insulator which has one coulomb of charge has that astronomical number of electrons displaced to one boundary, we believe. (But no one has yet counted them, because the electron is too small to see and we cannot locate its position accurately by any means.)

When a conductor permits the potential energy of the charge to convert itself back to actual energy of motion, all of these electrons return to their normal positions, and we call the resulting flow of electrons a "current." The unit of current is the ampere, and one definition of an ampere is a flow of one coulomb of charge in a time of one second. time. Current is an electroDYNAMIC effect, while charge can exist without motion, and so is electroSTATIC in nature.

Charge is a measure of quantity, similar in many ways to the "pint" or "gallon" of liquid measure. A given amount of charge may, if released from its static state, produce any amount of current, depending upon how long the flow lasts – in exactly the same way that a gallon of water may drip through a tiny hole over a period of hours, or may be emptied by overturning the bucket in a matter of a fraction of a second.

The other fundamental electric unit, the volt, is a measure of potential, tension, or pressure. Though the volt is a static unit, it is like the ampere in that one coulomb of charge may be stored at any voltage.

What determines the voltage for any given quantity of charge is the electrical capacity of the insulator in which the charge is stored. "Electrical" capacity is not quite like "physical" capacity; the thicker the insulator, all other things remaining equal, the smaller its electrical capacity, but the greater the surface area the larger the electrical capacity will be. This comes about because charge is stored *only* at the boundaries between the insulating material and the conductors. The farther apart these boundaries are, the more pressure is required to keep all electrons displaced; the larger the area of each boundary, the more room for charge.

To distinguish between physical capacity and electrical capacity, we call electrical capacity by the special name "capacitance". The voltage associated with any particular amount of charge depends not only on the amount of charge, but upon the capacitance in which the charge is stored. The unit of capacitance is the "farad", for Faraday, and one definition of a farad is that capacitance which will store one coulomb of charge at a potential of one volt.

Other definitions make use of specified measurements for area, separation of the surfaces, and kind of insulating material, so that we can reverse this definition of a farad and make it a definition for the volt – that pressure (or the potential energy) of one coulomb of charge stored in a one-farad capacitor. Two coulombs of charge in the same capacitor would produce a potential of two volts, and so forth.

The units of "charge" and "potential," then, as well as that of "capacitance," describe electrostatic effects or "static electricity," while the unit of "current" describes an electrodynamic effect. When a circuit includes either a chemical cell or a generator which converts motion to electrical energy, the electrostatic units of potential and capacitance may still take part in the circuit, but the flow of current is the essential item.

In today's world, most authorities don't use Maxwell's own names of "actual

energy" and "potential energy" to describe the motion-storage-motion cycles. Instead, the component which Maxwell called "actual" and which is the "motion" part of the cycle is called "the magnetic field" and the component which Maxwell called "potential" and which is the "storage" or "displacement" part of the cycle is known as "the electric field."

Either of these fields can, apparently, exist apart from the other so long as no motion is introduced. A permanent magnet has its own magnetic field, but if it is at rest no electric field surrounds it. Similarly, a charged capacitor contains an electric field, but if no current is permitted to flow no magnetic field is associated with it.

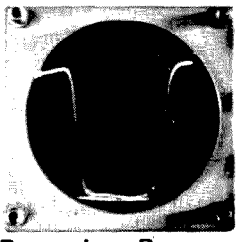
Introduction of motion, whether it is the physical motion of the field with respect to its surroundings, the physical motion of the surroundings with respect to the field, or the electromagnetic motion produced by providing a complete circuit and thus permitting discharge of an electric field, results in the presence of both kinds of fields. Whether the motion causes the field to exist, or the field causes the motion, is not really a matter worth worrying about. Sometimes it seems to be one way, sometimes the other, and in many cases nobody can determine which is cause and which is effect.

At this point, we have defined "charge" as the displacement of a specific number of electrons, "capacitance" in terms of physical distances, "current" in terms of change and time, and "potential" in terms of charge and capacitance.

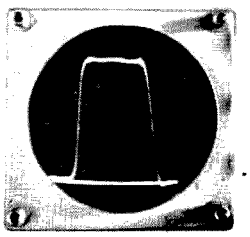
While we still have no knowledge of the *nature of that "aethereal medium" which* is known as "the electromagnetic field" – in fact, no one has much more knowledge of its nature than that set forth by Maxwell in his original description, when he wrote that the electromagnetic field is "that part of space which contains and surrounds bodies in electric or magnetic conditions" – we *do* have an explanation of a possible means by which voltage and current are produced and propagated.

And, as it turns out, that's all we really need in order to do anything we desire in electronics.

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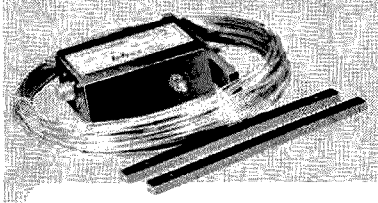
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Now that we know more than we really wanted to about charge, voltage, current, and capacitance, let's look at some other factors involved in the flow of charge or "electricity."

Just before we began examining the nature of voltage, we saw in passing that a given amount of charge may, upon being permitted to flow from a static state, produce any amount of current depending upon how long the flow lasts.

At that time, we compared it to the tiny drip of a gallon of water which might take hours, and to the sudden overturning of a gallon bucket. We did not, however, look for the factor which controls how long a flow of current may last, starting from a given amount of charge.

Such a factor does exist, of course, and we've already made its acquaintance. It's "resistance," caused by interaction between free and bound electrons in any normal conductor.

The unit of resistance is the "ohm," for Georg Simon Ohm, who first formulated the law which relates voltage, current, and resistance. Ohm's Law is of such fundamental importance to all electrical work that it comes as something of a surprise to discover that Ohm formulated the rule simply as a by-product of his studies into the effects of heat upon resistance, and in his original description, did not express the law in the formula which today bears his name. The familiar formula is the invention of Maxwell, who included the law as one of his 20 equations.

We saw, when looking at the qualities which separate conducting materials from insulators, that conduction is accomplished by "free" electrons, which are free to migrate from place to place as contrasted to "bound" electrons which are held firmly in place in an atomic structure. We also saw in that study that free electrons always lose some of their energy as heat, because of interaction between free and bound electrons.

This interaction within any normal conductor is the major factor limiting current flow within that material. It, in turn, depends upon the number of free electrons within the material, which is determined by both the material itself and by the physical size of the conductor. Different materials have different ratios of free to bound electrons, and the larger the conductor the more free electrons will be available within any one cross-section of it.

The more free electrons a material contains, the better that material is as a conductor. We say it has low resistance. Silver has the lowest resistance of any normal conductor, but copper is almost as good a conductor and costs considerably less. For this reason, copper is the most widely used conductor.

Some materials have few free electrons, although still enough to be classed as conductors rather than as insulators. The resistance of such materials is high. One such material is carbon. Another is the nickel-chromium alloy known as "nichrome".

True resistance, or "pure" resistance to use a jargon term, is the conversion of electrical energy to heat. Many effects other than true resistance can also cause energy to be "lost" from a circuit, though, and most usually these effects are also known as "resistances." One example is the radiation of energy from a circuit such as a transmitting antenna.

The difference between true resistance and these other effects which may also be labelled as "resistances" is that true resistance produces heat while "imitation" resistance does not. The "radiation resistance" of an antenna, for instance, has no heat associated with it; the energy is radiated instead.

In a complete circuit with steady current flow – a "direct current" or "DC" circuit – the potential, current, and resistance are all related by Ohm's Law, which states that the potential in volts is equal to the product of the current in amperes multiplied by the resistance in ohms. Stated in its most familiar form, $E = IR$, where E is voltage, I is current in amperes, and R is resistance in ohms.

If we know any two of these three quantities, the third is determined by Ohm's Law. Using high school algebra we can rearrange the formula to find resistance if voltage and current are known ($R = E/I$),

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or current if voltage and resistance are known (I = E/R).

A number of memory aids have been developed to help students remember Ohm's Law. One used by our staff is the simple word "ear," which is what comes out if you try to pronounce "E-IR" and consider the "=" to be silent. If you're handy at algebra this is all you need, because it's not difficult to turn the formula around into the other two versions.

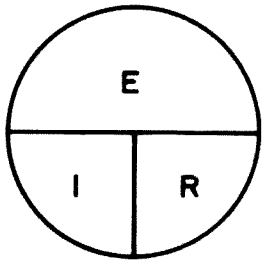


Fig. 2. This simple picture may help you remember Ohm's Law. E stands for voltage, I for current, and R for resistance. To get formula for calculating any one if you know the other two, cover the unknown and the picture shows you the right formula. For instance, covering R gives E/I.

Another involves an Eagle, an Indian, and a Rabbit. The Eagle flying above the prairie sees both the Indian and the Rabbit below him, so E = IR. To the Indian, the Eagle is above the Rabbit; I = E/R. To the Rabbit, the Eagle is above the Indian; R = E/I. Figure 2 shows still another which uses a circle divided into one half and two quarters to provide the same illustration.

Although these simple versions of Ohm's Law are those most widely used, it's necessary to keep in mind that they apply only to DC circuits. If the current is changing, modifications become necessary. A chemical battery provides DC. A simple generator, however, produces current of quite another kind which we will take up a little later.

With voltage, current, charge, resistance, and capacitance all defined, we have completed answering our question. There's still one more major electromagnetic effect, but it does not apply when current flow is steady – so we will wait a bit to study it.

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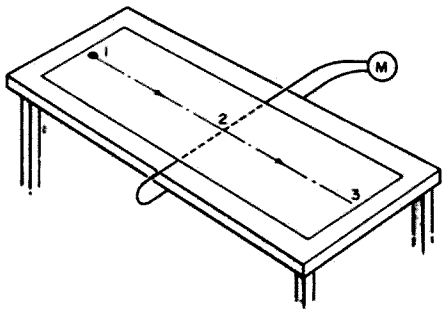


Fig. 3. Principles of converting motion to electric current are shown here. Magnet at 1 is moved along line shown, crossing wire. Motion of magnet induces flow of current in wire. See text for more detail.

What About AC? Just a couple of paragraphs back we mentioned that while a chemical battery provided DC, a simple generator gives current of quite another kind. Let's look into this a little deeper.

We saw earlier that according to Maxwell's theory, a flow of current is associated with any motion of a conductor within a magnetic field.

Assuming that the magnetic field is of constant strength, then the faster the motion the greater the current. If the polarity of the field is reversed, the direction of current flow will also reverse.

These facts provide a method for converting mechanical motion into electrical energy, by using a magnet and a conductor, one of which remains stationary while the other is moved.

Figure 3 shows an impractical example to illustrate the idea, before we go on to more practical techniques. Let's assume that we have a wire conductor stretched flat on a large table-top and covered with a thin sheet of paper to provide a smooth surface. Let's assume also that we have a small, powerful permanent magnet, which we are free to move across the table.

Let's start at Point 1, well away from the wire, and move the magnet at a constant speed up to and across the wire at Point 2, continuing on away from it to Point 3, and at all times measuring current in the wire.

As we do so, we find that the instant the magnet begins to move a small amount of current flows. At the beginning, the flow increases rather slowly, because during any tiny fraction of a second the distance from magnet to wire undergoes little change so long as the distance is large.

For example, if Point 1 is 100 in. from the wire, then if the magnet moves at a steady rate of one inch per second, it will move the 1/10 inch from 100 to 99.9 inches in the first 1/10 second. The change in distance is only about 1/10 of 1%. Since "speed" is a measure of distance moved in a given time, the effective speed is low.

But when the magnet is only 10 inches from the wire, then in the next 1/10 second it will move the 1/10 inch from 10.0 to 9.9 inches, which is 1% of the distance or 10 times as much relative motion as at point 1. The effective speed is thus 10 times greater than at the start, and current will also be 10 times greater.

When the distance is down to only ½ inch, the 1/10 inch moved in 1/10 second is such a large part of the total distanct that it's difficult to decide just how much faster the effective speed is, but it must be at least 20 times greater than at the 10-inch distance or 200 times greater than at the start.

Current flow, likewise, is great. In fact, the current intensity reaches its peak as the magnet passes over the wire. Once the magnet has passed Point 2, it's moving away from the wire rather than toward it,

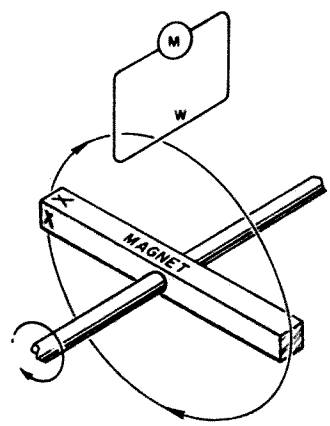


Fig. 4. This sketch shows the simplified generator we use to illustrate the nature of ac and how it gets that way. It's just a bar magnet on a rotating shaft, with one wire just outside the path of the magnet poles. As magnet rotates, currents are induced in wire. Intensity of current depends upon shaft position at each instant as discussed in text.

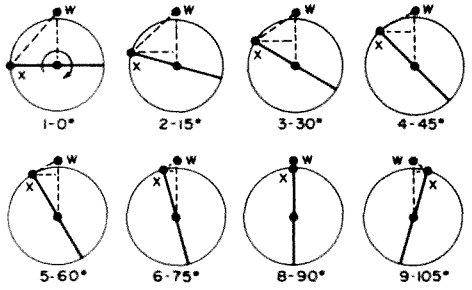


Fig. 5. "Snapshot" sketches of our simplified generator, seen end-on, as it would appear at eight points from 0° to 105° of rotation. All rotation here is clockwise. Key factor is distance from nearer pole tip to our wire, indicated as distance XW. Triangles (dotted lines) help us to calculate this distance for each position of magnet.

and so the "effective motion" is becoming smaller at exactly the same rate that it increased during the approach. This means that effective speed is decreasing, and so must be the current flow.

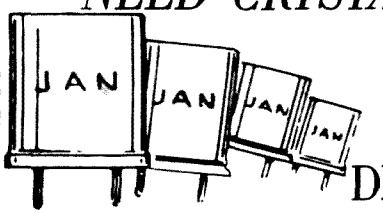
The straight-line or "linear" motion we've used in this example isn't very practical for normal use. Rotary motion is much simpler to handle in actual machinery. Practical generators put either the magnet or the conductor on a rotating shaft, and the other half goes on a stationary frame known as the "field" close by.

For our illustration, let's put the magnet on the shaft, and keep a single wire just outside the circle described by the rotating tip of the magnet. We'll use a bar magnet, with its two opposite poles, to make the illustration a bit more practical. Figure 4 shows the arrangement.

When we change from "linear" to "rotary" motion, the way in which effective motion varies with time undergoes a few changes of its own. Let's try to see just what happens; to do so, we'll have to use a little geometry – but very little. All we have to accept from the geometers is the rule for determining the length of one side of a triangle, if we know the other two sides.

Figure 5 shows several successive "snapshot" sketches of our generator, seen end-on, as the shaft turns through a little more than ¼ of a full revolution. Starting at a point which we arbitrarily called "0°," the snapshots show the relation between mag-

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net and wire at 15-degree intervals as the shaft rotates.

You can see that the distance "XW" from magnet to wire is the "effective distance," and the "effective motion" during any period of time must be the change in this distance. "Effective speed" must be related to the effective motion.

If the total length of the magnet is 20 inches, then the radius of its circle of rotation will be 10 inches. At the time of our first snapshot, the magnet pole is as far from the wire as it can get without the other pole being nearer. This happens when the magnet and the line from wire to shaft form a right angle. Because of this, distance XW is the hypotenuse of a right triangle, and each of the other sides is 10 inches long. Applying the geometry at this point, we find that distance XW is 14.142 inches.

At the second snapshot time, XW has become shorter. It's down to about 12.1752 inches. By the third, it's down to 10 inches, and by the fourth, to about 7.65 inches.

That is, during the time between the first and the second points the effective motion was 1.97 inches, between the second and the third the motion was 2.18 inches, between the third and the fourth, 2.35 inches, and so on. Just as in the case of linear motion, the motion during a fixed period of time becomes larger and points X and W approach each other.

The change in effective *speed* is also important, though, and this is where much of the difference comes in. Unlike the change in effective motion, the change in speed is greatest when X and W are furthest apart.

The calculations to determine this are much too much arithmetic to go into here (in fact, they are so much arithmetic that we fudged and gave the problem to a computer – Fig. 6 is the table of results it gave us back), but when we do them we find that the relative change in speed between snapshots 2 and 3, for instance, is 0.2083, while from 3 to 4 it is only 0.1711 and from 4 to 5 it's down to 0.1310. The change becomes smaller until X passes W, then gets larger again.

In Fig. 6, the column headed "SPEED CHANGE" shows the continual change of effective speed as the shaft is rotated.

Students who have been exposed to trigonometry may recognize the triangles dotted into Fig. 5 as bearing some resemblance to the "unit circles" used to define and illustrate the various trig functions.

As it happens, the resemblance is so great that it turns out that effective speed is related to the sine function of the angle through which the shaft is turned.

Now that we've seen how the effective motion changes with changes in shaft position, let's perch ourselves right on that wire at Point W and watch the magnet poles as we rotate the shaft.

When the shaft rotates, each pole in turn "rises" over the "horizon" formed by the rim of the circle, as in snapshot 1 of Fig. 5. It moves rather slowly at first, but picks up speed rapidly.

As the pole approaches us, its effective speed continues to increase, but the

Angle	Distance XW	Effective Motion	Speed Change
*0	14.1421	0.000000	0.000000
5	13.5118	0.630331	0.630331
10	12.8558	0.656051	0.025720
*15	12.1752	0.680523	0.024472
20	11.4715	0.703699	0.023176
25	10.7460	0.725536	0.021837
*30	10.0000	0.745991	0.020456
35	9.2350	0.765027	0.019036
40	8.4524	0.782606	0.017579
*45	7.6537	0.798696	0.016090
50	6.8404	0.813265	0.014569
55	6.0141	0.826286	0.013021
*60	5.1764	0.837734	0.011448
65	4.3288	0.847588	0.009854
70	3.4730	0.855828	0.008240
*75	2.6105	0.862439	0.006611
80	1.7431	0.867408	0.004969
85	0.8724	0.870726	0.003318
*90	0.00001**	0.872387	0.001661
95	0.8724	0.872360**	0.000000**
100	1.7431	0.870726	0.001634**
*105	2.6105	0.867408	0.003318

* – Points used for "snapshot" calculations (Fig. 5)

** – Results affected by accumulated tiny error in computer.

Fig. 6. Calculations of Distance XW, effective motion, and change in speed, as produced by computer. See text for discussion.

acceleration slows down. During the final part of the approach, its speed is great but almost constant. It passes us at a rather rapid rate, and immediately begins to slow down as it curves away.

The deceleration is slow at first, but as speed becomes less and distance increases, the rate of deceleration increases in an exact mirror of the acceleration rate during the approach. Finally this pole disappears over the "far horizon" just as the opposite pole "rises." This succession of pole-passages continues so long as the shaft is rotating.

The result, in the circuit of which our wire is a part, is a continual reversal of current flow as one pole "sets" and the other "rises." At these instants, current flow in the wire is zero because the opposing magnetic fields of each pole "cancel out." In between these "zero" points, the nearer pole's field takes over, and current flow either rises to a positive peak or falls to a negative peak, as each pole in turn flashes past the wire.

Because the effective speed of the magnetic field, and the resulting intensity of current flow, is associated with the sine of the angle through which the shaft has turned, we call the resulting current a "sine wave."

Because the current alternates in direction twice during each full revolution of the shaft, as the two opposite poles pass, we also call it "alternating current" or "ac."

Early experimenters had no practical use for ac; the reversals of polarity cancelled out many of the effects in which they were most interested. To get rid of it, they put a rotating switch called a "commutator" on the shafts of their generators, to reverse the connections between the conductor and the outside circuit whenever the current direction reversed and thus cancel out the effect of the current reversal.

They also used many windings, rather than just one conductor, so that at any one instant they were taking current only from the conductors which were at that time generating peak current.

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Only recently has the "alternator," or simple generator such as we've described here, come into popularity. In a practical alternator, the magnetic field is produced by a field coil rather than by a permanent magnet, and a multi-turn output winding rather than a single conductor is used, but the principles remain the same.

One important factor necessary to talk about ac, which was not required with dc, is a measure of the number of times each second that the current changes direction. The older standard for this was the "cycle per second," with one cycle being the result of one full revolution of the shaft in our simplified generator. That is, one cycle includes a positive peak, a negative peak, and two zero crossings (one in each direction). A cycle may begin at any point on the waveform, and when that point has been reached the next time from the same direction, the cycle is complete.

Recently, the U. S. adopted an international standard of frequency called the "hertz" in honor of Heinrich Hertz, who was the first person to test Maxwell's theory by transmitting and detecting radio waves. One hertz is the same as one cycle per second.

Whether measured in hertz, or in cycles per second, the quantity so measured is called "frequency" because it is a count of the frequency with which the current alternates.

Closely allied to "frequency," but not identical, is the term "wavelength." A wavelength is the distance travelled by the energy during the course of one cycle, to put it roughly.

If the current flow moves at the speed of light, then wavelength in meters is equal to 300,000,000/frequency in hertz. This comes about because the accepted figure for the velocity of light is 300,000,000 meters per second. If, for example, an ac wave is alternating at a frequency of 50,000,000 hertz, then in one second it will undergo 50,000,000 cycles, and these 50 million cycles will be able to travel for 300 million meters in that time. Each of them, then, must stretch over a distance of 300/50, or 6, meters, so the length of each wave, or wavelength, is 6 meters.

If frequency is expressed in megahertz or megacycles, the conversion is simplified and becomes wavelength in meters = 300/f where f is frequency in Mc.

In dealing with any ac circuit, it's essential to remember that what makes it ac is the fact that the current's direction reverses as time passes (which requires current intensity to change with time, as well). This fact makes ac behave very differently from dc in many instances. One of the differences shows up when we try to measure ac voltage or current, and we'll look at that in a little while. Another difference brings us back to that one remaining major electromagnetic effect, which we postponed looking at in the previous discussion. It's time, now.

We have seen, with the help of Maxwell's theory, how a flow of current is always associated with a magnetic field, and have also learned that a magnetic field in motion is always associated with either a current (if a complete circuit is present) or a charge (if no complete circuit is available). It follows, with a little thought, that if a current is flowing in a circuit and anything changes the flow of the current, the associated magnetic field must change – and this resulting change must, in and of itself, be associated with a "secondary" or "self-induced" current which is completely different from the original current.

As it happens, this "self-induced" current is of such a polarity as to oppose the change of original current which called it into being in the first place, which means that electric current flow has a property very similar to that called "inertia" in ordinary moving objects. This property tends to keep any current flow constant, and opposes any change.

Because it is produced by "self-induced" currents, this inertia-like property is called "inductance," and it is measured in a unit known as the "henry." The usual definition of inductance involves the "line of magnetic flux" which we saw much earlier is probably imaginary rather than real. By this conventional definition, inductance is a measure of the number of lines of flux which encircle the total

current ("linkages"), per ampere of current. The henry is defined in this manner as the number of linkages divided by current in hundred-millionths of an ampere.

Although this definition leads to some complicated mental corkscrews, when one attempts to figure out how to count the number of imaginary lines in an unbounded region of space, it's probably as good as any other. In actual practice, inductance is measurable only by its effect in a circuit.

The "true" inductance of any specific inductor depends not only upon the material, shape, and size of the inductor, but also upon the amount of current flowing in it, the rapidity with which current flow changes, the number, size,, conductivity, shape, and proximity of all surrounding objects, and several other factors.

With so many uncontrolled variables in the picture, any measurement or calculation which claims to give "true" inductance is more than somewhat open to doubt!

The most important fact to keep in mind about inductance is that it represents an effect which impedes any change of current flow in a circuit. The more rapid the change, the greater the effect. Similarly, the greater the absolute flow, the greater the effect. Once a current flow becomes steady, however, its associated magnetic field is fixed and does not move. As a result, the "self-induced" current disappears, and inductance is no longer a factor.

Thus inductance applies to dc circuits only during the small periods of time when current flow is changing. Since current flow in an ac circuit is continually in a state of change, inductance is an important factor in the functioning of ac circuits.

Now let's look at some of the differences in measurement between dc and ac.

In most dc circuits, measuring voltage or current is relatively simple. Both voltage and current are steady as time passes, and all we must do is determine the intensity.

But in an ac circuit, current is constantly reversing its direction and voltage follows right along (though in some ac

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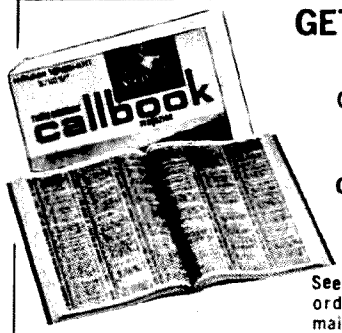
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circuits there may be a time delay between current and voltage). If we want to determine intensity, we must also determine just when to take the measurement.

Because the current is zero at two points in the cycle, at a positive peak at one point, at a corresponding negative peak at another point, and at all other points is balanced by a corresponding value of opposite polarity, if we simply take the average intensity over a complete cycle, both current and voltage will average out to zero regardless of the peak values of either.

This is exactly what happens when we try to measure ac with a dc meter. The meter faithfully averages values over complete cycles and indicates zero, even though the actual energy may be enough to burn the meter out.

One way of measuring ac might be to look only at half of the cycle, and take the average over that half-cycle. Then we could multiply the reading by two to account for the other half-cycle, or simply ignore it. This kind of measurement is sometimes made, and it's called the "average" value.

Unfortunately, the voltage and current readings we get by "average" measurement of ac don't correspond very well in practice to dc readings. We expect a 110-volt light bulb to have the same brightness on 110 volts of ac that it does on 110 volts of dc. If our 110 volts of ac is based on an "average" reading, the bulb will be much brighter on the ac.

It would be nicer to have a method of measuring ac which would give readings directly comparable to dc values. Such a method exists; we can measure the amount of heat generated by ac in a resistor, and find out how much dc is necessary to produce the same amount of heat.

Such a value is known as the "effective" value of the ac, and also as the "rms" value. The "rms" stands for "root mean square," and refers to a mathematical technique used to convert other kinds of measurements to effective values.

When ac voltage or current is not labelled as being in some other method, the effective or rms value is understood. Thus the 115 volts of the ordinary wall plug is 115 volts rms; the "average" voltage of this same plug is just under 103.

Sometimes the easiest way to measure ac is to measure intensity from zero to either peak. This is known as "peak" voltage, and its value is 1.414 times the rms value for the same signal. "Peak" voltage of 115-volt household power is about 163 volts, which is why some simple power supplies produce about 150 volts of dc from a "115-volt" input. It's "peak" voltage that you feel when you touch a defective appliance and get shocked.

In a few cases the most meaningful measurement is from one peak to the other, or "peak to peak" readings. With a sine wave signal, this is 2.83 times the rms value or twice the peak reading; with other ac waveforms there may be no way to relate readings. Peak-to-peak values are important because they represent the maximum pressure or potential impressed by the signal upon any insulators.

In an ac circuit, voltage, current, and resistance are not related so simply as they are in a dc circuit. This means that in order to handle ac, we must make some minor modifications in Ohm's Law. Unfortunately, our space for each installment of this course is somewhat limited, and so we must delay any discussion of the modification until next time when we will go on to examine more effects of ac. Now we must go on to see just what makes a circuit.

What Makes A Circuit? All the way through this installment, we've been taking the word "circuit" for granted in order to build some basic ideas. Now let's find out just what makes a circuit a circuit.

One of the standard textbooks used to introduce engineering students to radio defines an electric circuit as "the path taken by an electric current from its source through all of the components of the circuit and back to the source."

The only thing wrong with this definition is that it uses the idea of "circuit" to define "circuit." Let's modify it just a bit, and call a circuit "a continuous path through which an electric current may travel." That's not completely accurate

either, but by taking the two definitions together we can proceed.

For now, let's look only at dc circuits. We'll go into ac circuits in the next installment. We'll assume that a battery is our source of electric current during the rest of this discussion.

The simplest circuit, using our definition rather than the textbook version, would be merely a length of wire connected from one pole of the battery to the other. Current would flow, but not much else would happen.

In order to do anything useful, we must include "components" in our circuit, and that brings us to the textbook's definition.

The most common qualities affecting simple electric circuits are resistance, capacitance, and inductance. Of these, capacitance and inductance are effective only when current flow is changing, so we'll consider only components which produce resistance when they're included in our circuit. Such components are called resistors.

Each component in a circuit is known as a "circuit element." The connecting wire is not usually considered to be an element if the circuit contains anything else.

Circuits are divided into three major categories, known as "simple," "series," and "parallel" circuits. "Simple" circuits are those which contain only one circuit element, such as the one shown as A in Fig. 7.

"Series" circuits contain two or more elements connected end to end, so that the current will pass first through one element, then through the next, and so forth until the current has passed all the way around the circuit. A series circuit of two resistors is shown as B in Fig. 7. Elements of a series circuit are said to be connected "in series."

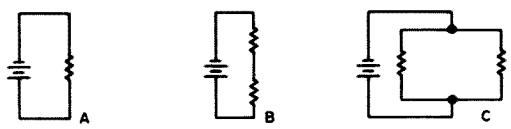


Fig. 7. These are, respectively, "simple" circuit (A), "series" circuit (B), and "parallel" circuit (C). Number of circuit elements (resistors here) and division of current flow are factors determining which type is which.

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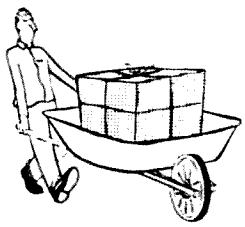
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"Parallel" circuits contain two or more elements, none of which are connected in series. Each element is connected directly to the power source, so that current which flows through one element does not flow through any of the others. A parallel circuit of two resistors is shown as C in Fig. 7. Elements of a parallel circuit are said to be connected "in parallel."

The major difference between "series" and "parallel" circuits is that in a series circuit, all the circuit current flows through each element in turn, while in a parallel circuit, that current which flows through one element returns directly to the source and does not flow through any other elements in the circuit.

From this difference, we can determine how resistors combine in both series and parallel connections to give total resistance. If two resistors are connected in series, all the circuit current must flow through each. In the first, a part of the energy will be converted to heat, leaving less for the second. In the second, the remaining energy will be converted to heat, so that none remains to return to the source.

Let's use the circuit of Fig. 7B, and assume that one of the resistors has a resistance of 5 ohms and the other is a 10-ohm unit. Let's assume also that we measure total circuit current and find it to be 2 amperes.

By the rule set forth in Ohm's Law, the voltage across the first resistor must be 2 x 5 or 10 volts (E=IR). Across the second, it's 2 x 10 or 20 volts. Total voltage of the battery, then, must be 10 + 20 or 30 volts.

Now we apply Ohm's Law again, using the 30-volt value we just calculated for battery voltage, and the 2-ampere measurement of circuit current. Resistance must be 30/2 or 15 ohms (R=E/I). In a series circuit of resistors, then, total resistance must be the sum of the individual resistances.

Let's try it again with the same two resistors connected in parallel (Fig. 7C) and using the same battery. We know now that the battery's voltage is 30. We can use Ohm's Law to calculate current through each resistor individually. Through the 5-ohm resistor, it's 30/5 or 6 amperes (I=E/R), and through the 10-ohm unit it's 30/10 or 3 amperes. Since none of the 6 amperes going through the 5-ohm resistor flows through the 10-ohm unit, the total circuit current must be the sum of 6 and 3 or 9 amperes.

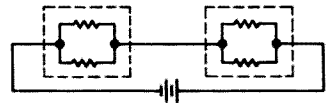


Fig. 8. Not all circuits are as simple as plain "series" or "parallel" connections. Subcircuits shown in dotted boxes are paralled connections, but subcircuits themselves are in series. Total circuit is called "series–parallel" but it could be reversed to "parallel–series" without changing components or connections simply by re-drawing dotted boxes. Most real circuits are like this, only more so.

With a 30-volt source and 9 amperes circuit current, we return to Ohm's Law and calculate total resistance as 30/9 or 3.333 ohms (R=E/I) – less than that of either resistor alone.

Effective values of resistors in parallel can be calculated in other ways, too, and some are much simpler. The way we've done it here, though, shows *why* resistance is lower, and is the basis for all the others. We'll meet the other ways next time around when we go into the manner in which other circuit elements combine in series and in parallel.

Incomplete circuits, which are complete except for their power source, can themselves be considered as a sort of circuit element in a larger circuit. Figure 8 shows a larger circuit with two such "subcircuits" in it, each outlined by dotted lines. Each subcircuit is a parallel circuit, but the two are connected in series. Such an arrangement is known as a "series-parallel" circuit.

Most actual working circuits are even more complex than Fig. 8. The science of electrical engineering is largely devoted to determining how circuit elements are combined to form circuits, and using this knowledge to design new circuits.

Next Time

We've reached the end of our space for this installment, and still have not answered all the details of the FCC questions we chose for this round. This happened because the FCC questions mix

together some relatively simple ideas which are true in dc circuits, and some much more difficult concepts which apply only to ac circuits. This time, we've had to establish the foundation for ac circuits – but we haven't had space in which to build on it.

Next month, we'll go more deeply into ac circuits and complete the answers to this month's FCC questions, as well as to several more involving finer points of ac circuit theory. From there, we'll be in position to tackle more advanced problems.

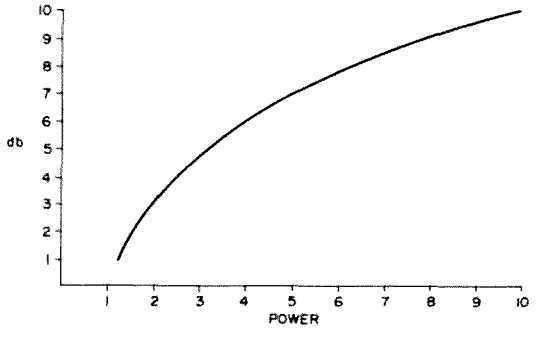
If you want to study elsewhere while waiting, there are few texts available which follow the manner in which we're developing basic theory. If you can obtain a copy of "A Source Book in Physics" (by W.F. Magie, Harvard University Press, Cambridge, Mass., 1935, 10th printing 1969) it will give you the original reports of most of the leading scientists in electricity and radio up to 1900.

. . . Staff ■

DB to Power

Here is a chart for changing decibels to power gain. Examples:

If an exciter runs 100 watts and it is fed into a 500 watt linear amplifier, the power gain would be five times and, by using the chart, the decibel gain would be 7 dB.



If 100 watts is fed to an antenna and the feedline has 3 dB loss, by using the chart, half of the power is delivered to the antenna.

Higher values of dB can be calculated by multiplying both co-ordinates by ten, by a hundred, etc.

Doug Pongrance WA3JBN ■

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Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen K1FWF, high school student, 51 Pine Plain Road, Wellesley, MA 02181. HF and vhf antennas, vhf transmitters and converters, AM, SSB, product data, and surplus.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, NY 11360. Novice help.

Joseph W. Botwinick K2EJI, 131-60 231 Street, Laurelton, NY 1141. Technical information required for Novice, General and other licenses.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, VA 22042 General.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, IL 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Glen H. Chapin W6GBL, 3701 Trieste Drive, Carlsbad, CA 92008. HF and vhf antennas, novice transmitters and receivers, vhf converters, semiconductors, receivers AM, SSB, general, surplus.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, VA 22307. Amateur TV, both conventional and slow scan.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans LA 70118. Novice help and general questions.

George T. Daughters WB6AIG, BS, MS, 1560 Klamath Drive, Sunnyvale, CA 94807. Semiconductors, vhf converters, test equipment, general.

Gary De Palma WA2GCV/9, P.O. Box 1205, Evanston, IL 60204. Help with AM, Novice transmitters and receivers, vhf converters, semiconductors, test equipment, digital techniques and all general ham questions.

Steve Diamond WB6UOV, college student, P.O. Box 1684, Oakland, CA 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, vhf antennas and converters, receivers, semiconductors, and product data.

Frank M. Dick WA9JWL, 921 Isabelle Dr., Anderson, IN 46013. Will answer queries on RTTY, hf antennas, vhf antennas, vhf converters, semiconductors, mobile, general, and microwave.

Willy P. Everaert ON4WM, Park ten Hove, 97, 9230 Melle, Belgium. SSTV (test tapes available), weather satellite picture decoding systems, and digital circuits. Appreciates IRC's for return postage on inquiries.

David D. Felt WB6ALF, 79 East Highland Ave., Sierra Madre, CA 91024. Semiconductors, IC's, television, test equipment, product data.

Louis E. Frenzel, Jr., BAS, 11287 Columbia Pike, Silver Spring, MD 20901. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

Paul Gorrell, high school student, P.O. Box 228, Mashpee, MA 02649. Novice transmitters and receivers, hf equipments, CB to ham gear conversion. Marine to ham gear conversion, Civil Air Patrol Communications, all aspects.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, CA 95240. TV, hf antennas, SSB, vhf antennas and converters receivers, semiconductors, and general questions.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, NY 14619. Specializes in vhf/uhf solid-state power amplifiers, but will be glad to make comments on any subject.

D. E. Hausman VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Charles Hill WA7LQO, 237 Bridge St., Baker, OR 97814. Slow scan TV.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO NY 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 SW Salmon St., Portland, OR 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Douglas Jensen W5OG/K4DAD, BA, BS, 2505 Broadway, #1704, Houston, TX 77012. Digital techniques, digital and linear IC's and their applications.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, WI 53402. Novice transmitters and receivers, general.

Ira Kavaler WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, NY 11236. SSB transmitting, color TV, computer programming and systems, digital radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Ronald King K8OEY, Box 227, APO NY09240. AM, SSB, novice transmitters and receivers, hf receivers, RTTY, TV, test equipment, general.

Ken Knecht K8VNT/2, Box 39, Clintondale, NY 12515. Novice help and general questions.

G. H. Krauss WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, NY 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitters and receivers, vhf antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Tom Laffin W1FJE, Hillsboro, NH 03244. Authoritative information on ham radio's fundamental beginning works. Documentary info on

the historical scientific period 1887 to 1954. References include but not limited to The Annual Report of the Smithsonian Institution, electrical engineering texts, National Electrical Codes, the hard-to-find data.

Bert Littlehale WA1FXS, 47 Cranston Drive, Groton, CT 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

J. J. Marold WB2TZK, 279 Farmers Ave., Lindenhurst, NY 11757. General.

Wayne Malone W4SRR, BSEE, 8624 Sylvan Drive, Melbourne, FL 32901. General.

Charles Marvin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, OH 44084. Will help with any general amateur problems.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, CA 94952. Double sideband.

Fred Moore W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, PA 19047. Novice transmitters and receivers, hf and vhf antennas, vhf converters, receivers AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Eduardo Noguera M. HK1NL, EE. RE, P.O. Box Aereo 774, Barranquilla, Columbia, South America, antennas, transmission lines, past experience in tropical radio communications and maintenance, hf antennas, AM, transmitters and receivers, vhf antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, CA 91780. ATV, vhf converters, semiconductors, general questions.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, MN 55060. AM, SSB, novice transmitters and receivers, hf receivers, vhf converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, PA 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

Howard Pyle W7OE, 3434 7th Avenue, S.E., Mercer Island, WA 98040. Novice help.

Robert Scott, 3147 East Road, Grand Junction, CO 81501. Basic electronics, measurements.

Pfc Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO NY 09742. Help with current military gear, information from government Technical Manuals.

Walter Simciak W4HXP, BSEE, 1307 Baltimore Drive, Orlando, FL 32810. AM, SSB, Novice transmitters and receivers, vhf converters, receivers, semiconductors, mobile, test-equipment, general.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, NY 11357. General.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, IL 61820. Antennas, transistors, general.

Jon Teich WB2JAE, 22 Olden Road, Ediron, NJ 08817. General assistance and problems with rigs.

James Venable K4YZE, MS, LLB, LLM, 119 Yancey Drive, Marietta, GA AM, SSB, novice gear, vhf, semiconductors, and test equipment.

Hugh Wells W6WTU, BA, MA, 1411 18th Street, Manhattan Beach, CA 90266. AM-FM receivers, mobile test equipment, surplus, amateur repeaters, general.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, CA 91504. Club licensing classes and Novice problems.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, OH 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Joseph Zaroff WN3NEQ, RR 1, Washington Crossing, PA 18977. Novice gear, antennas, vacuum tube circuits, construction of homebrew projects.



Protection for Grid Dipper Coils

All who have used one will agree that a grid dip meter is indispensable to the active homebrewer. It will insure that your tripler will triple rather than double. It will double as a wavemeter or signal generator and in general is one of the most useful test instruments for the builder.

As a result of the multiple uses to which they are put, the average grid dipper soon becomes rather dog-eared. The coils especially are subjected to abuse above and beyond the call of duty. Some coils have the protection of an outside coil form which keeps the coil proper in good condition; however, more often the coil is wound on the outside of the form and covered with a thin layer of coil dope or shrinkable tubing. Either of these soon loses its effectiveness and mechanical problems set in.

Having experienced the above problem with my dipper, I have tried several cures. The one to be described answers every requirement. I bought a bottle of "Clear-Cast" casting plastic from a local handicraft supply store along with the required small bottle of catalyst. Mix a small portion (3 to 4 ounces) according to the directions on the bottle. Remove any loose coil dope or tubing and dip the coil into the plastic up to the terminals. Remove the coil and let it drip a few moments, then suspend it, terminals up until dry. Repeat with each coil. A second coat may be added after the first is dry, but the mixture is thick enough that it really isn't necessary.

Tests before and after processing indicate no change in coil characteristics. With this tough coating the life of your coil should be extended to the life of the terminals.

William P. Turner, WAØABI

Turner M+2

A microphone with a built-in compressor/amplifier that can give you 20 dB more talk power on sideband.

With sideband transceivers getting more plentiful on the used market and the very reasonable price on the Heath single banders and the WRL Duo Bander, many of us have gone mobile and more are giving it serious thought.

The big disadvantage is the inefficiency of the antenna system. A 100 ampere alternator with the Heath Kompact KW linear will help overcome the antenna losses. But so will fully modulating the transceiver by adding a speech compressor.

The Turner M+2 microphone has a silicon transistor compressor built in, complete with a 7-volt battery that will last under normal conditions up to twelve months. There is an output control on the back of the mike.

Perhaps you will be interested in the results I've had using the M+2 microphone with my Heath HW-12A and Kompact KW combination. I first used the Turner 350-C, the one that Heath sells for mobile use, and got signal strength reports from several local stations. Then I switched off the linear and changed to the M+2 and found that the signal reports were exactly the same as before!

Using both the M+2 and the Kompact KW with the HW-12 results in a tremendous mobile signal.

You should use a scope to properly set the gain controls on the mike and on your rig since the output of the M+2 is very strong; as great as -30 dB to 1 megohm load. With this much talk power you can very easily overmodulate or flat-top. I run the mike volume control at 9 and the mike gain on the rig at about 2 o'clock.

The price of $23.70 is probably the least you will ever pay for 20 dB gain. Good luck with your BIG mobile signal.

. . . Ralph Compton WA5JVQ ■

YOUTH FORUM REVISITED

With all the turmoil among our young people today it's almost dangerous to entitle a column youth forum. Relax; I'm not going to urge anybody to seize the administration building at the ARRL or any such nonsense. The purpose of this column is to promote interest in ham radio in our teenagers.

The problem is not to get them to get their Novice licenses; it's so easy that anybody can do it in a month or less. The problem is to get them to go for their General or Advanced. Many Novices never go on to get their higher class license. The most common excuse is that they "lost interest." I can see where they would. Let's face it – the Novice band is crowded, there's very little DX, and no voice operation. You can work just about as much DX on Citizens' Band as on the Novice band – and you can use voice.

While talking to one of the local Novices, I noticed that his interest was beginning to drop. I invited him over to the shack after supper to try and boost his morale. I had the transceiver running when he came in and invited him to tune around 20 meters to get the feel of it. The results were amazing. He went wild when he heard a few DX stations. I worked a couple to impress him a little more. For the clincher, I went down to 75 and let him listen to some of the European gang coming in. This left him numb. His best DX on 80 had been a WN9. The last time I saw him he was hitting the books hard and I believe he's going to make it now that he has an idea of what ham radio is really like.

Many more people would be willing to work for a ham license if they had a good idea of what ham radio is like. Many of the magazines which are aimed at electronics in general (PE, EI) look at ham radio from a Novice point of view. The ham magazines are incomprehensible to a non-ham.

So if you know someone who has expressed an interest in ham radio, invite him to the shack and show him why it's worth the effort to learn code and theory. Give him a true picture of ham radio; don't just hand him an old copy of *How to Become a Radio Amateur*, which shows him how to build a regenerative receiver for the ham bands (and other white elephant projects).

Many Novices come to me asking what equipment they should buy. My checking account is still hurting from some of my financial misadventures as a Novice, so I guess that puts me in the "veteran" class. The lessons I learned might be of value to others, too. If interest warrants, I will list a few tips in a future issue on spending money for ham equipment.

. . .Andy Bourassa WA1LJJ ■

MOBILE CW RECEIVER

Just before vacation time many amateurs begin to get the urge to build portable equipment. Often last-minute construction jobs never get finished in time for vacation, especially if new circuits using FETs are tried. This is a story of a similar rush project where reliable tube circuits were used to finish the receiver the day before vacation. The receiver worked so well, the information is presented here for those of you who want to plan ahead for next year's vacation trip.

This 80–40 meter receiver uses four 6U8 tubes so that only one tube need be taken along on field trips for the spare. Each pair of tubes has the filaments wired in parallel so that the entire filament supply can be operated from the 12V car battery. The plate supply only draws about 15 mA, and the receiver can be run from

Ed Marriner W6BLZ
528 Colima Street
La Jolla CA 92037

three 45V dry batteries if a mobile supply is too much work to construct.

Designed especially for CW reception, a product detector was used. A 2.5 kHz bandpass i-f filter was made from two surplus low-frequency crystals. Plug-in coils were used to make wiring and band changing easy. Only one coil has to be changed when going to the other band. The mixer and rf coils are tuned to both 80 and 40 meters by using a large broadcast-type tuning condenser which covers both of the bands in the tuning range.

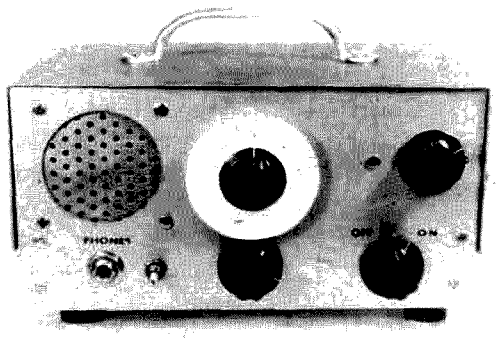
The low frequency i-f gives good selectivity, but images from strong commercial stations could pop in the ham band if they are near in location.

Theory

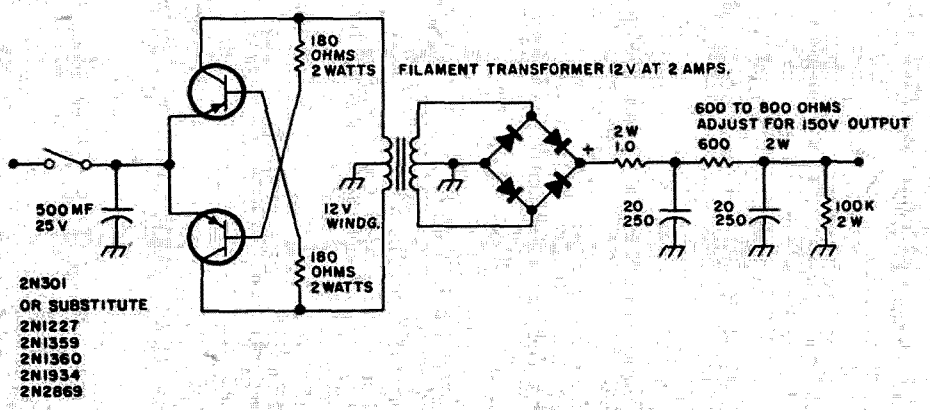
Starting off with the rf stage, the antenna signal is coupled to the grid through L1 and L2 and then fed to the mixer through L3 and L4. These coils are tuned by a ganged 365 pF tuning condenser so that one coil covers both the 80 and 40 meter bands. The ratio of coil to condenser is adjusted to have enough capacity to prevent unstable oscillations which might reflect back on the oscillator tuning.

The variable oscillator which tunes 3955–4455 kHz for the 80 meter band or 7455–7755 kHz for the 40 meter band is injected to the mixer through a cathode follower. This follower is necessary to prevent signals in the mixer from getting back into the variable oscillator and causing frequency shift. The follower is necessary. The oscillator oscillates with a strong signal to give enough injection to the mixer. Insufficient signal to the mixer also causes mixer oscillations.

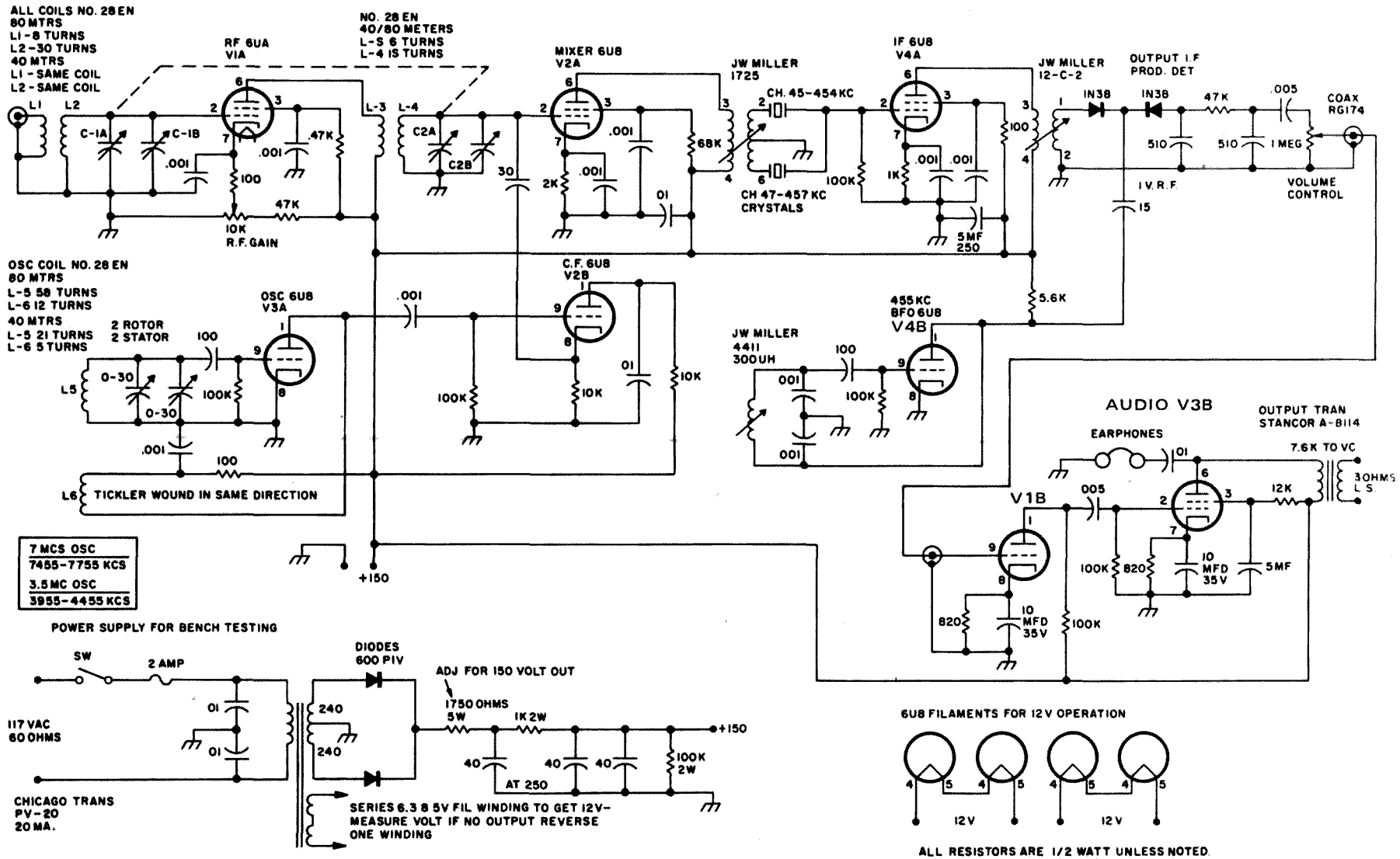
The output of the mixer is fed through a crystal filter which has low loss, and only one i-f stage was necessary since there was



Front view of receivers showing the epicyclic ball-bearing drive head for the dial fitted with a home made dial plate. The mechanism is 10 to 1 and can be obtained from British Radio, 142 Wisconsin Ave. NW Wash. D.C. Upper right are the ganged rf and antenna coil tuning condensers. Center lower knob is the rf gain control.



Mobile power supply for CW receiver.



Schematic diagram of mobile CW receiver. Note: power supply should be kept away from receiver to keep field away from modulating the audio output transformer.

enough gain, and selectivity was obtained in the low-frequency channel crystals. This signal output from the i-f was fed into a product detector and then to the audio stages.

Circuit Discussion

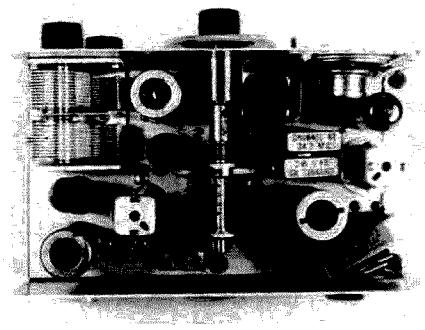
Power to the receiver should not exceed 150V to comply with requirements to the triode section of the 6U8s if long life is expected. As it turns out, there is plenty of gain using 150V, and the receiver works very satisfactorily with only 150V or less. Volume is more than enough for earphone reception, but the 6U8 will drive a speaker, although the tubes were not designed as audio output speaker drivers. The output transformer is a little higher impedance than necessary, but it cuts down on the tube current and is better when used as the auido choke for earphone reception. The tiny transistor speaker could be replaced with a larger speaker – there is enough drive.

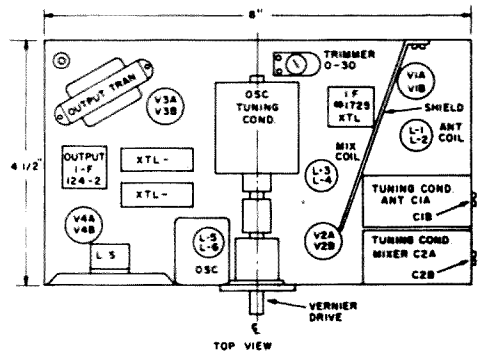
The diodes used in the product detector should be of the germanium type to obtain leakage; do not try to use silicon types if the 1N67s or 1N58s are not available. Low-leakage diodes cause the signal to block.

Crystal filters were made from two surplus crystals to give a selectivity of 3 kHz. If too narrow a bandpass is used the i-f stage will oscillate. A J. W. Miller No. 1725 i-f transformer specially designed for coupling into the crystals was used. It tunes the 455 kHz channel 45 and channel 47 ranges. Experimenting is in order if you have the time to try various bandwidth crystals and adjustments of the i-f transformers, but the crystals indicated will give all the selectivity necessary. The i-f signal needs about 1V from the bfo to mix properly and be passed on to the 47 kΩ, and 500 pF capacitors used as the rf filter.

Construction and Tuning

The receiver is built on a California Chassis type A-119 which is 4¼ x 8 x 1½ in. The dial drive is a British Radio vernier type No. 892 with a 5-to-1 ratio. More ratio could be used because the receiver does tune sharply. Parts placement can be changed around, but it is suggested the tube arrangements be used as shown. It was found necessary to remove the variable oscillator from the same envelope because the mixer tube pulled the oscillator. Experience is a great teacher, and some of the troubles can be prevented by following instructions.





Top view of receiver with the crystal filter and output i-f transformer to the left of the tuning condenser. Note the oscillator coil is shielded.

Once the receiver is wired it can be aligned by listening to the 40 meter signals, although initial adjustments can be made with a signal generator and a modulated tone when peaking the i-f's. During the tuning, be careful you don't screw the slugs off the threads. Since only 150V was used it was not necessary to use the customary 1000Ω and .005 μF bypass condensers around the various supply leads to prevent interaction between circuits. Placing a single 40 μF condenser on the chassis gave

enough filtering to stop coupling except for the audio supply where a 5 μF and 10Ω resistor helped the filtering.

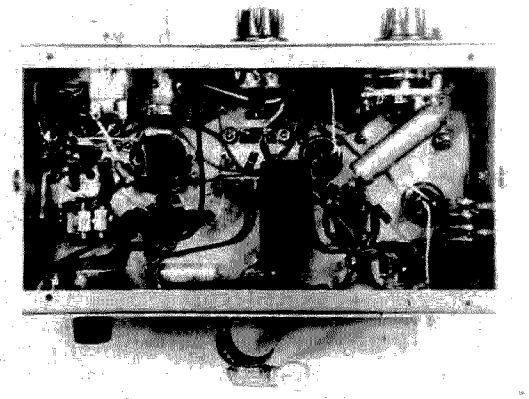
Once the i-f stages are aligned, peak up the rf and mixer condenser C1B and C2B. It is best to set the mixer tuning at a maximum peak, then adjust the trimmer for most signals, and then go back and peak the antenna trimmer. If there is not enough capacity, tuning of the condenser will cause oscillations. The trimmers were set almost full mesh with the number of turns given in the coil table. A separate antenna trimmer could be mounted on the panel if antennas are often changed because the trimmer has to be retuned when another antenna is used. Best performance can be obtained if a good antenna is used, such as an 80 meter or 40 meter resonant antenna, and although the receiver will work on ten feet of wire, the input is designed for low-impedance coupling.

While probably not necessary, it is a good idea to use the EBY tube shields over the tubes to prevent coupling between parts. An aluminum shield between the mixer and antenna coils is another good suggestion. The more shielding is insurance against possible oscillations between circuits.

The circuits in this receiver all tend to be high Q which gives the most signal output; however, it is best to be safe, and back off if necessary on some adjustments to give reasonable output with no oscillations. Since C1A and C2A tune the range 80 to 40 meters, there is no need to change plug-in coils when going from one band to the other. The condenser tracks satisfactorily. The oscillator coil does have to be changed.

The most difficult problem with aligning the receiver is to calibrate the variable tuning condenser. It is easier to pull out plates to obtain the proper bandspread and increase the 0.30 pF trimmer to compensate for the loss in capacity. The output of the oscillator can be picked up on the receiver in the shack if you have one; if not, try using the grid dip oscillator. Make sure the signal is on the high side of the amateur band because it is easy to slip the trimmer over to the low side. Once you set the 7.0 MHz position on zero, the 3.5 MHz position can be brought to zero by spreading the bottom turns of the 3.5 MHz oscillator coil until it is positioned on zero also.

During the tuning process the bfo was assumed to be peaked for a beat note by screwing in and out on the slug coil for proper tone. Try to use two silver mica capacitors across the bfo coil. Heat tends to make the small ceramic types drift.



Bottom view of receiver. Bfo slug coil is between earphone jack and rf gain control.

The details of the adjusting process can become boring to those more familiar with construction but this description should be satisfactory for those building the receiver. It will become apparent as you play with the adjustments what you can and cannot do, or where the limits of adjustment lie.

This receiver performs very well with plenty of volume for all normal portable or mobile work where CW is the primary interest. It will mount on the dash of most autos by cementing magnets to the bottom of the chassis unless you have a padded dashboard. No attempt was made to put it on 20 meters, but it would work except that the images would be more of a problem as you need more selectivity using the 455 kHz i-f's when going to the higher frequencies.

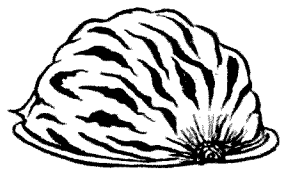
. . . W6BLZ ■

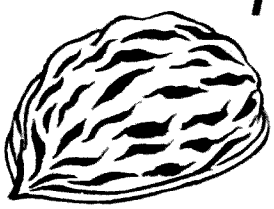
Alan Shawsmith VK4SS
35 Whynot Street
West End, Brisbane, Australia



QSLing

HAM RADIO'S OWN CON GAME





In every human activity, sadly, there is to be found a racket of some sort and the QSL *situ* in our hobby is no exception. Compared to the magnitude of swindles outside of amateur radio, the card business falls under the classification of petty exploitation.

Those who don't or won't QSL fall into several categories. Firstly, there's the well intentioned bloke who is always *going* to get down to writing out his QSLs – but years have gone past and he's not faced it yet and you could safely take the odds at ten to one that he never will. There are many like this among us whose sins are those of omission, rather than commission. Lack of discipline is probably the commonest of human failings. While it is possible to tolerate these characters and philosophically accept the couple of dollars lost in IRCs, AMs, etc., in a futile attempt at verification, they nevertheless are living a daily lie, in that they blithely go on ending each QSO with "QSL sure"; adding nothing worthwhile to the standard of ethics or goodwill of our hobby.

Then there is that broad group who *don't intend* to QSL. These are the cheaters, the deceivers, and the small-time opportunists. They bring to ham radio the doubtful tone of the rat race outside. To these fellows, ethics and fair play are virtues for the squares. Among them is the type who sends his address with each QSO and promises to reply "as soon as I get yours." The verification never comes. The intention only is to take.

More than one possessor of a rare call is playing the averages. A DXpeditioner in Africa, who subsequently sent no cards, was heard telling a mate in a ragchew, "I've worked one hundred VKs; that should cover me in that direction."

In any company there's always a shylock or an exploiter who wants more than his pound of flesh. One who is determined to *sell* his call at the best possible price and show a little profit on his QSL printing costs at the same time. His request is anything up to five IRCs and SASE with your card – or make a contribution pse? For what? A check shows he has access to

a bureau, so a card is sent via this facility, followed by another, and maybe at a later date, yet another, but ND.

Then we have the manager/ham setup, a combination that's brought more than one piece of connivance into existence. True, the QSL manager has a real place in the modern scene. Most do their job ethically and well and provide a prompt service. Their assistance to hams in isolated areas cannot be overemphasized. But many managers are superfluous and the deceivers in this field are growing. I lay the blame directly on many U.S. hams. Anyone with a rarer than average call is swamped with offers to write the QSL service. The true reason being that the helper helps himself out of the bog of nonentity that threatens to flood those in countries that have a large ham population. It's a two-way status stretch. Both attain greater importance and identity and if the business is handled properly, there's sure to be a little capital profit.

My call sign is not one to be put up in large letters or attract a queue of callers, but offers of QSL services have come from the States (possibly quite ethical) and one commercially minded character wrote from the U.S. offering to relieve me of the workload at a pretty stiff fee per thousand cards sent. A middle man, out to show a profit both ways and gain the status of a manager to boot.

In defense of making panting aspirants pay to obtain a rare QSL, one DXer put it to me this way: "I really only come on the air to give the world a new country. Every time I press the key the queue quickly lengthens to infinity. I make several thousand QSOs a year. The QSL costs are beyond me. Nor can I afford the time."

In such a case the adjunct of a manager is quite in order. In fact it's a must, but the charitable bit about helping the boys to a new one is in reality most likely a rationalized half-truth in order to seek privilege. He's providing a new country, yes – but gaining considerable status in the process. The cost of the QSLs are still largely his responsibility, or a matter of arrangement with his manager; and the body of hams who make a QSO should not have to meet the cost of printing two QSLs and postage both ways. G2MI, who through his bureau has probably handled more QSLs than any other ham alive, recently made a comment to the effect that it behooves every ham to handle his own QSL affairs if he possibly can. I heartily concur.

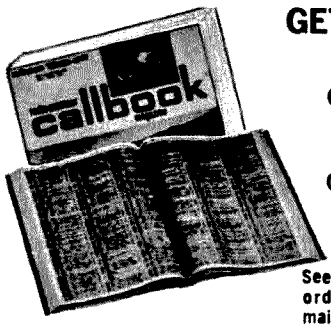
In days past, when I sent IECs, SASEs and "contributions" etc. to those who requested them, my QSL return was between 75 and 80%. Nothing outstanding in this considering I was buying what I wanted. However, after a personal moment of truth wherein I rearranged my values a little and decided the dollars posted could be better used elsewhere, I sent my QSLs via the bureau (where this was possible) to a manager or direct S.M., but with *no* IRCs. Result: a 15% return. Draw your own conclusions. As in other levels of our society, the humble pay and the exalted claim privilege.

I was recently instructed by a manager to send SASE with my card for direct reply only. "Have no bureau and can't afford the time to cope with stamps and envelopes," he said. Special circumstances do occur, but in general the manager who has not the machinery or the time to provide an equitable service should not set himself up as a QSL caretaker. Getting stamps for SASEs is not possible for many hams.

Of course the line of distinction as to what's ethical and what's snide is often difficult to draw. The fast, modern, country-hopping ham DXpeditioner is continually calling for contributions to defray expenses and promote the venture further. Fair enough, and I've been happy to oblige, but the case customers naturally say, 'I'll put in a buck or two, if I get a QSL.' The end result of this in some cases is a little bribery or corruption.

The inequities outlined above are but a few of those indulged in. We all know of the much-boasted claim of those who simply consign SWL reports to the waste-paper basket. To write a reply and encourage a beginner is beyond the range of their compassion. Then there's that group who will only send a QSL to those from whom they want a verification. No thought is ever given to the many who may want a QSL

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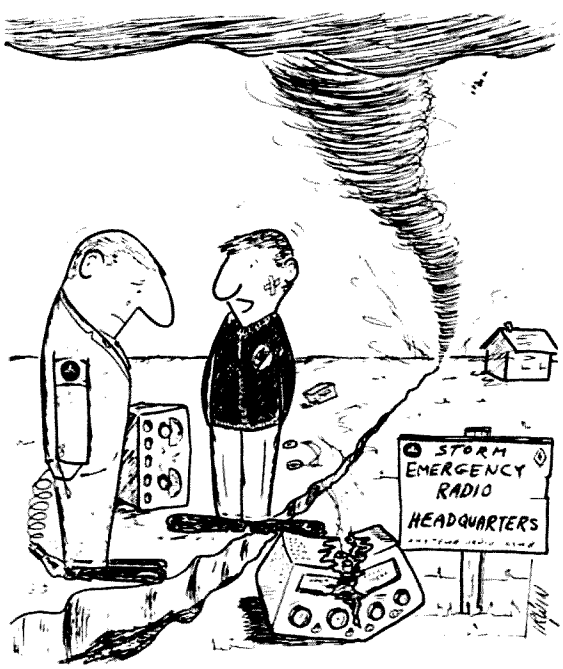
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"If you have a dime, I'll see if the phones are working!"

from them. The day of the counterfeiter is not past either. They've appeared in the past and will do so again. Why spend hours and hours chasing a real rarie, when you can print your own? But these sharpies come quickly to grief. Printing and getting away with a phony QSL is harder it seems than passing a bad $10 note.

This brings one to the point of how to deal with the QSL deviate or purify the scene in general. Unfortunately, no encouraging prognosis is possible. So long as so few are so fanatically chased by so many, the prospect of elevating our QSLing standards is not bright. The blackmarketeer will continue to exist so long as he has the clientiele of Mr. Average Ham. Even the most honorable rare-country ham, on finding his QSL mail laced with dollars, is tempted to operate out of cupidity rather than for the art of DX itself. Is it the QSO or the almighty dollar that's sought? Likewise, the "seekers" don't really want the QSO – only the QSL. From here it seems only a simple step to dispense with the ten-second QSO and just send the card as a swap for the dollar.

The best improvement that can be hoped for, it seems, is an eventual "buyer resistance" to the card sharpie. DX-wise, the world is rapidly shrinking and an increase of hams in some of the emerging countries will take the novelty out of many exotic calls. I am optimistic too, that much of the activity created from pursuing new awards will become more selective. A glutted market results in discerning applicants, and no one will deny that the award field is pretty well saturated.

A gentleman's agreement is in truth an unwritten law and by this virtue alone it should be more binding than one imposed by constitution. It appears than many simply don't understand the real meaning of such an agreement. The ethics of QSLing are such that it is tawdry piece of business to *sell* one's call in a service that's called *amateur*. If the spirit of our hobby is to be truly observed and preserved, it is obligatory on each and every ham who says he QSLs to do so at par – or as near to this as possible.

. . . VK4SS ■

(continued from page 10)

transmitters, scanning receivers, handie-talkies, and such would proliferate.

The FCC would not only gain by getting back their 11 meter band for its original purpose, but would get several million dollars in fees for the new license and would get rid of the fantastic headache of even trying to monitor CB. 220 would, like other amateur bands, be self-monitoring. The FCC has a responsibility for the number of engineers and technicians in the country, since their regulations so profoundly affect this situation; this new license should greatly improve this situation.

The FCC would gain . . .the amateurs would gain . . .the country would gain . . .CB'ers would gain . . .and the manufacturers would gain. Everyone gains, and the best part that no one loses anything! Can you ask for a better deal than that?

It is estimated that some 25% of those active on CB now are unlicensed and that when the new prices go into effect that this could go up to 75%. The type of operations that we would have on 220 would eliminate the things that make illegal operation possible. Everyone would have a call . . .would be listed in the Callbook . . .would have QSL cards, etc. The whole thing would become legitimate. The ease of direction finding and the lack of skip contacts would soon stop all illegal operations.

DX'ing on FM

Ken was so enraptured with the beauties of southern New Hampshire that I thought it might be fun to blow his mind by taking him on a tour through the Presidential Range of the White Mountains, some 120 miles north of Peterborough. Ken packed five of his seven children into his car, but two kept popping out so Lin and I took them along in our car, along with Sage, now just five months old.

We headed up north, taking the back winding roads. We used mobile units on 146.94 FM to keep in touch. The system worked pretty well except for repeaters breaking our squelch a good deal of the time. Everyone enjoyed the Morse Museum in Warren, N.H., and the Lost River Caves. The high point of the trip probably was the tramway trip to the top of Cannon Mountain, with an FM Handie-Talkie in hand. From the top of Cannon we were able to break the repeaters all over New England. The best contact we had was with a mobile in Ontario, a total of 200 miles away, through W1KOO on Mt. Mansfield in Vermont. We had no trouble breaking W1KOO, a little over 50 miles away, and working stations one after another through it. We also made some contacts down in Massachusetts through W1ALE in Concord, N.H., about 70 miles away.

That evening, while visiting my folks just outside of Littleton, N.H. I tried the Handie-Talkie and found that I could break W1KOO from there too. Again, this was a good 50-mile hop. So I sat there in the livingroom of the farmhouse, talking with fellows over in Vermont, New York and up in Montreal. I also managed to work Ken, just three miles away in a motel, and guide him to the farm. The Handie-Talkie transmitted on 146.34 and received on 146.94, and since Ken had no crystals to receive on 34, he had to talk with me through W1KOO, a one-hundred mile path, even when he was parked in front of the farm.

The next day we headed off to Mount Washington. From there we made contacts through W1KOO and W1ALE again, plus W1ABI, and perhaps others. The local FM and TV transmitters raised the noise level and made it a lot more difficult to work out. Ken did a bad job on his hand on the way up the mountain, burning it when his radiator boiled over, so we didn't stay on top nearly as long as we might otherwise have. It takes third degree burns to keep Ken off the air for any length of time.

It is difficult to really describe the excitement of making contacts from the farm, but I've been visiting it for most of my summers for well over forty years and it is home to me. We've never had electricity there, nor water other than from a spring up on the hill which runs into the cellar and can then be pumped into the kitchen with a hand pump. It is about as remote as you can get these days. Yet, remote as it is, I could sit there and talk for hundreds of miles with my little Handie-Talkie.

One Dollar a Copy?

We increased the cover price of 73 earlier this year, expecting the worst. There was little choice . . .either we made the magazine smaller, publishing fewer articles, or else we had to raise the price. We took the gamble. We figured that since 73 published more articles than the rest of the magazines, the extra quarter was not really significant. We figured, but we didn't know.

The results are now coming in and I must truthfully tell you that the sales of 73 did change. . .they changed a lot more than I guessed they would. The sale of 73 went up. . .way up! 73 now has, our distributors tell us, the largest single copy sale of any amateur radio magazine in the world, and by a comfortable margin.

Subscriptions have been peaking up too, probably as a result of new readers paying a dollar for a copy and then noticing that there is a substantial saving when one buys a three year subscription for $12 instead of $36 on the counter. With more postage increases on the way, our subscription rates will have to go up appro-

priately. Sorry about that. Right now the lifetime subscription is by far our best bet, and you can buy it on the installment plan! $10 down. This too, alas, will be going up shortly. . .probably to $75.

Other Magazines

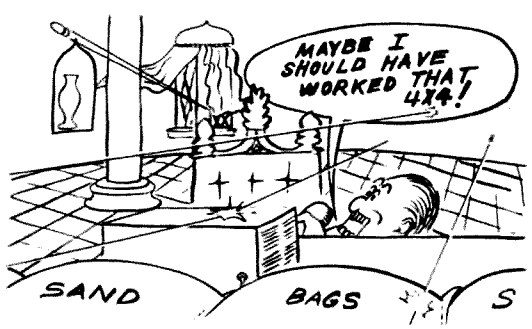
Four more magazines are in the works up here at 73 Hq. Radio Today is still in its early stages with just two issues published so far and acceptance at a high level from both readers and advertisers. Once it is strong enough to keep itself going we will begin work on introducing the next one. One is in the two-way field. . .one is a house organ for one of the big conglomerates. . .one is an entertainment magazine. . .one is about bringing up children. . .and a possible fifth is being researched for the gourmet field. There is a lot of money to be made in publishing today (in everything but the ham field), so this is a good time to take advantage of the plant we have built up, a plant that has the equipment and personnel to produce a number of magazines ready for printing, complete printing equipment for promotion and small books, etc. All this is only being partly used for 73 and Radio Today, so we can turn out a few more magazines.

Opportunities at 73

Our magazine is growing, as you may have noticed. This means that we have to add to our staff every now and then. Possibly you have thought about working in your major hobby. . . ham radio. . .if so, you might enjoy working for 73. We occasionally have openings that could best be filled by interested amateurs. The openings may be in bookkeeping, circulation, promotion, advertising, proofreading, typing, drafting, printing, or layout or even a combination of several of these fields. Most of all we need people who are interested in helping amateur radio to progress rather than just wage earners. Drop us a line and a resume if you like 73 and are interested in living in the most beautiful spot in the country.

. . . Wayne ■

DX'ing from JY



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Please would it be possible for you to insert my name and address in 73 as I would like to get one or two pen pals in other parts of the world who are as intensely interested in all aspects of ham radio, TV, and electronics as I am. I am nearly 16 years of age, in my third year at college (fifth form), and have all the normal interests that a healthy male of my age should have, especially the above mentioned. I have been sold on radio, etc., since I was 11 years old and collect every knowledgeable radio book I can get hold of. I would be most grateful if you can help me out.

Warren Dyer
25 Bronwyn Street, St. Albans
Christchurch 5, New Zealand

CW

I have followed the incentive licensing bit somewhat casually but have to ask, "What is all the furor about, anyway?" Is it truly possible that the chance of being reexamined in some relatively elementary theory and being required to send and receive CW at the blinding speed of 13, or even 20, wpm has the whole fraternity shook up? If this *is* a fact, it suggests to me that many amateurs have: (1) lost pride in accomplishment, (2) have no business in the hobby anyway, or (3) worse yet. . .both! Ergo, in my honest opinion, ham radio would be the better off without them. The feeble excuses of "no time," "too old," "can't study," etc., leave me cold. I have raised a family, am working full time on a second-career job (23 years in the navy), am taking an extensive correspondence course and considering additionally some college night school. Incentive? You better believe it! I *want* my license, my rig, and all that goes with it, and I can tell you here and now, they're going to have to take it away from me! Maybe others don't care, but as for myself, the idea of earning something has a great amount of appeal, including an Extra class ticket I picked up in 1954. As far as I can remember, this cherished bit of wallpaper, at the time, offered *absolutely nothing*, promised nothing (I already had Class A), except a large measure of satisfaction in being able to do it.

Except for those who have a physical handicap, anybody who wants a license (any level) and has guts enough to work for it, can get it. Those lacking in this attribute and content to be second best, will, as always, sit on the sidelines moaning and groaning that they are being discriminated against and wait for somebody to give 'em something for free. Well, fellows, have fun. It's cold and lonely out there, but you'll have plenty of company with the rest of the second team.

You may well ask if I belong to the ARRL. You bet I do! I have been so affiliated for over 30 years and I know where responsible, demonstrated leadership for amateur radio may be found.

Gene R. Cate W4GEF
3647 Huckleberry Street
Memphis TN

Is this the familiar if-I-did-it-so-can-you syndrome?

. . . Ken

CW Not Anachronistic

Thanks to Wayne Green for the kind words for CW in the April issue of 73. I do not know Wayne's authority for the statement: "I know that the military uses it very little any more." *Very little* is not defined, but I assumed it was approaching the insignificant.

I do not agree because my information acquired over more than 30 years of being closely connected to the Navy's communication-electronics is probably closer to the real facts than Wayne's. (The Navy was still military the last time I looked.) I am in a position to know that there are still a large number of messages being moved by CW each month over Navy circuits (or else the reports to headquarters in Washington are being gundecked). Several hundred radiomen are being qualified each month in CW in service schools. In addition, Speed Key Certificates are being issued each month. Talk to Navy radiomen who have been on distant deployments and you will learn that it is not uncommon to have to resort to CW as a last ditch mode when TTY and voice circuits go out. True, other modes carry a large part of the traffic these days, both in military and commercial circles, but CW remains the old, reliable standby when others fail.

It is still my professional judgment that people should not rush out and buy lilies for CW's funeral. They may need them for their own first.

Lester Harlow WB6ZNW/W4CVO
5015 Cape May Avenue
San Diego CA

The Navy fought off airplanes and aircraft carriers for more years than anyone thought they could. . .perhaps they will be able to hold onto CW as long as battleships.

. . . Wayne

Ham Exchange

In the past months I had some nice, some very nice experiences with Ham Hospitality. In the middle of May, we had a couple of days off school, and I was invited to New York by 4X4FN, who showed me around town (around city, sorry). We had a real nice party with hams at his house, and also at YO2BOs, where I had the chance to meet a couple of American and foreign amateurs.

My second very interesting experience took place the first week of April. I was invited to Purdue University by CP6DG and CP5FQ, and had a great time too, of course!

I am an exchange student in the states until August 1970, and do not have any relatives here, and in my case, Ham Hospitality is doubly nice, and I am thankful to 73 for having had the idea and having put it in practice! I hope many other hams will be able this way to experiment and enjoy international friendship.

If anyone is in HB9 land, my address is Susi Christen, En Brochat, 1093 La Conversion, with

the phone number (021) 280504, I would be very glad to serve as a guide and do everything possible to make everybody feel at ease.

Susi Christen HB9OE/W4
International House J.S.U.
Jacksonville AL

So There!

73's needle is stuck! Still harping against incentive licensing! It is here; let us face it! I speak now to the 73 staff.

For your own benefit, I suggest that you reread and reanalize Subpart A, General, 97.1, Basis and Purpose.

Amateur radio is not a *right*; it is a *privilege* to be earned; granted us under the control of the FCC by our government.

This continual harping reminds me of the story of the old hound sitting on a burr, howling in pain and just too damn lazy to get up.

I too, was very disturbed when incentive licensing was first proposed; then I reread 97.1 and decided to try and do something about it.

I am a stupid old ex-farmer and I obtained my first amateur license in 1964. In September 1968 I made the Advanced class on the first try, but I failed the theory on the Extra. One year later I again took the examination and made Extra. If I can do it, anybody can. Why bitch? Sure it is work, it takes time and study; but what is a hobby, if it is not something to consume some time? There is also a lot of satisfaction in achievement; try it. I held a radiotelegraph First back in 1932 under the Dept. of Commerce; but that elapsed in 1935 and was never renewed. I admit it helped me with the CW part and was also a factor in entitling me to a two-letter call; but I feel that any General today can at least make the Advanced – which has nearly all the privileges of the Extra.

I was glad to see the Callbook list license classifications. I know of one Technician who immediately disappeared from the 75 meter phone band, and heard of one Conditional who sold all his gear rather than submit to reexamination.

Now you are starting to bitch about paying $9 for a five-year license. Bet you spend more than that on 807s or golf or bowling or fishing and hunting. The Canadian boys now are paying $10 a year for their license. I would like to see them boost the license fee on the 10-4 boys up to $50; maybe that would take the hobbying out of it and return it to the business enterprises for which it was originally intended.

H. C. Swanson W0LZ
193 20th Avenue SW
Cedar Rapids IA

Maybe everyone who doesn't think the same way you do should be lined up against the wall and shot.

. . . Ken

Upgrading

I found Wayne's April editorial very easy to agree with. The ink on my Technician class license is barely dry. If I may, I will make a comment on the difficulty of the written portion of the exam. Admittedly I will fairly soon be one of those EE college graduates that Wayne mentioned. The material might make up a fair hour quiz for junior level EE students. As a text of technical competence, it is trivial.



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Several years ago Uncle Sammy sent me to thirty-eight weeks of electronics school at Treasure Island. Not many of the graduates would have to live with the license manual very long to pass the General. The same can be said about the graduates of junior college and community college vocational electronics courses.

The problem of cheating is very real. Probably the best answer is one suggested by radical Wayne Green: To have three witnesses present to administer the test (and all mail order tests).

I also feel that the Novice test should be renewable with a fee for renewal, but not for the original license. Also, that the Novice and Technician should be held concurrently.

I also have some thoughts on the invective, I mean incentive licensing, issue and the stupid butchering of the bands which I won't go into here, but there is one thing which might help. Since the FCC, with considerable prodding from Congress, is going to raise the license fees from $4 to $9 to help defray the cost of the operation of the government (what are our taxes for?), why not charge the $9 for renewal of the same class license, but retain the $4 for new licenses or upgrading to a higher license. This would put incentive into incentive licensing.

James E. Galbraith WA7NYM
403 College
Moscow ID

Techs on 10?

A few weeks ago I sat down and wrote 73 about my feelings on Techs getting part or all of 10 meters so they would be able to get the code practice needed to pass the General. Well, after reading Wayne's editorial in the April issue I again feel I must say something.

Referring to his "Solution to the Code Problem," I would like to give you an idea of what the club I belong to is doing. First, let me say that I am the president of this club and have only been a member for the last year.

I was given code practice by an oldtimer here in town who wanted to get new people interested in amateur radio. After a year and a half as a Novice, I was about to give up on the 13 wpm. At that time I heard the club was going to give code and theory classes so the Techs in the club could upgrade their licenses. I informed three other people of this and they too were welcomed (two were Novices and the other had no licenses at all).

Out of this club of about 20 there was not one Tech who was even interested enough to take the time to attend those classes.

Now, 9 months later our club again decided to give code and theory classes; as before, not one Technician even showed up. Still we were able to give 11 Novice tests and all were passed.

My point is this, all I hear is how the code is stopping some good hams from using the lower bands. If they were the least bit interested in putting a little effort out they could have those rights.

As for giving the Techs 10 meters I would go along if (and only if) it was for CW only. They say this is the only band they can practice on.

I would say if 10 meters was opened to Techs, there would not be any more CW on it than there is on 6 meters today.

Joe Dinger WA9YZD

Repeater Shortcut

Why make repeaters that come down to audio? Why not heterodyne the input to a high i-f, and then back to an output frequency. There are thousands of TV translators which utilize this mode of operation and some legal FCC-approved FM translators as well! (Broadcast FM.) (There are also some illegal broadcast translators working the FM bands that I know of.) Heterodyne microwave systems are very common.

So why not make up a ham repeater that operates the same way. It is easy to tap the amplifier stages to allow squelch cutoff or some such control of the output. The power consumption is less, and the ability to keep the signals sounding better is to be desired.

I'd like to know if anybody in the country is using a pure rf translator. Also, in comments re rules, I think we should keep them flexible enough so we are not ruled out of using translators as opposed to repeaters. Translators are easier, and generally less trouble.

Art Brothers W7NVY
Grouse Creek UT

Gil Boelke W2EUP has built and operated an all-solid-state translator that is completely portable. 73 is pushing him for an article on it. (For the benefit of other readers, Art Brothers was associate editor of FM. His recent request to the FCC for abandonment of Docket 18803 in favor of a new, more realistic docket has been receiving favorable official comment.)

. . . Ken

The Students Net

Various quarters of the amateur community take pride in the supposed courtesy of hams. Perhaps this often seems apparent in the way our bands sound under certain conditions, but I now feel an obligation to express my dismay at having to debunk this rumor.

During the month of May, many college campuses closed or went on strike, in protest to the invasion of Cambodia and the deaths at Kent State. It was natural that the strike leaders, needing some way of communication, and students at various campuses, needing information, should turn to amateur radio. Thus, the National Student Information Net was formed, expressly for the dissemination of information between colleges and into regular broadcast channels, at the campus radio stations. The net leaders checked with the FCC, and were in violation of no regulations, although many people did not agree with some of the information passed on the net (such as strike committee phone numbers, press releases, etc.).

Yet, throughout the operations of the net, on vaious frequencies (depending on band conditions), there were numerous jamming stations who attempted to impede operation of the net. Repeated statements of legality, allowal of breaking stations to express their dislike of net operations, and calling the FCC did not help. It was necessary to call the FCC every few minutes in order to have them attempt triangulation of the offending jammers. Tape recordings were made by net stations to help identify these illegal operators.

The melange of QRM was enough to fill a mental ward. Among the stations was "Big Ben," who whistled a tune familiar from church bells;

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"Whistler's Father," whose tunes were fascinating due to the way SSB changes harmonic relationships in music; a phone patch putting a busy signal over the net, several stations tuning up for hours on end, and KØIKB who called CQ on the 80 meter channel for hours on end, despite the fact that the rest of the band was quite clear and our constant telling him that the channel was in use.

Indeed, if courtesy on the ham bands were to be enforced, one could make a fortune selling wouff honggs to use on the lids who persisted in causing QRM to this net. None of the net operators interfere with MARS nets, but the corrupted "patriots" on NSIN with their QRM have shamed amateur radio more than any ARRL publicity campaign could make up for.

Fred Goldstein WB2ZJQ
President/trustee WA2YXQ
Passaic NJ

At the present time I am listening to the National Student Information Net on 75 meters. This is a net carrying information between college campuses on the student strikes now being held around the country.

For the last half-hour this net has been subjected to the worst heterodyning I have ever heard in all my years as a ham. A number of hams have been deliberately trying to jam this net. Their methods have included broadcasting pure carriers, music, and CW, etc. In addition to being illegal, this sort of action can in no way be tolerated either by the amateur radio community or by our American society as a whole. The survival of our society depends in a large part on the continued free exchange of ideas and accurate information.

I am a college student (at MIT), and though I'm not in support of the strike, I'm in 100% support of the right of these fellows to operate their net with the same respect and cooperation of other hams that any other amateur net receives.

I hope I never again hear such a display of immaturity and irresponsibility on the part of any amateurs and I also hope the amateur community as a whole will join me in reaffirming the high standards and long history of service of our hobby.

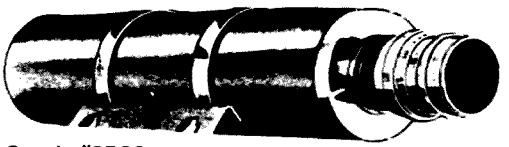
Stephen D. Umans K8ZBE

As I write this letter, I am very much angered at the actions of one individual whom I had the occasion of hearing tonight (May 11, 1970). I was listening to the Student Information Net on 20 meters when KØPMS started a QSO directly on the same frequency as the net. He was asked very courteously to QSY several times by the net control station; however, this was ignored by this individual. Repeated efforts on the part of the net control station to contact this individual were ignored, until he finally came back once to launch his attack. I only wish that I had recorded the following sequence on a tape recorder. This individual enlightened us on his philosophy for conduct on frequency usage. He claimed that his license had written on it that he was *assigned* this frequency and that he had every right to be there. He went on to say that this philosophy of his worked for him for years.

I take no stand on the issues discussed on the net, but I will take issue to this flagrant action on

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the part of KØPMS. If people like him are allowed to do such things I can see nothing but a dim future for amateur radio.

Gregory Niemyski WA1EMG

One good way of punishment would be for all amateurs to note the callsigns of the offending stations and boycott them in the future. A ham license is worthless if there is no one to talk to. . . . Ken

Not All Bad

I have been interested in amateur radio for a long time. However, I used to live in the backwoods and I could never find anyone to help me learn the code or theory involved. As a matter of fact, I could never find anyone who could even tell me that I needed to learn code or theory. Because of this, I never became a ham.

But now, with the formation of an amateur radio club at the college I go to, I have the help I need to obtain my license. Actually, I have been studying for a few years, and while looking for a good magazine on amateur radio, I came across an issue of 73. What a discovery!

I honestly believe that there is not a better ham magazine on the market today. I find it difficult to believe that you can cram a magazine so full of information and not run out of material. One feature which I really like, and which I hope you will continue, is the absence of those cardboard reply mail inserts. The only thing more irritating would be unnumbered pages. Please keep those cards out.

I would like to make a couple of comments on letters printed in 73. First, in the April issue, in a letter from Edgar Wagner, the first sentence in the second paragraph begins, "To a Englishman. . ." The correct wording should be "To *an* Englishman. . ."

Secondly, how about all those snide comments about CB'ers? I will be the first to agree that possibly 80% of the CB'ers operating are either operating illegally or don't know what they are doing and have no legitimate reason for being on the air. But there are some (yes, Virginia, there are some) CB'ers who will only operate legally and who also perform invaluable services. Besides, CB is a very handy thing to have around. Don't knock *all* the CB'ers.

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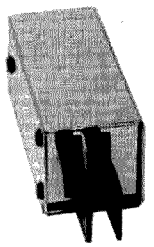
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"ham" types. Perhaps, when the FCC opens the 220 MHz segment to the Hobby grade of amateur license (no code, minimum theory), the days of CB misuse will be over for good.

. . . Ken

Who Needs Friends?

I just finished reading Ken's April editorial and wish to express a great big thanks for same. There must be some way of influencing or moving the FCC other than through the ARRL. I was so angry over the incentive licensing escapade that I dropped my membership in the League and do not intend to rejoin.

I got my Advanced ticket, but so what! If I want to work my friends I have to work in the high end of the band anyway, so it seems of actual little value.

I would go all out for incentive licensing if the higher classes could work voice in the top half of the CW portion of the band. This would make much more sense to me, especially since you can work CW over the entire band anyhow. Regardless, who needs a "friend" such as ARRL? Better I should have an enemy, for at least I would be suspicious of him from the very beginning.

Lavern Peterson KH6EKQ
45-323 Mahalani Place
Kaneohe HI

We believe it is time for the amateur radio operator to be represented by a national organization directed by and for the members. It would be nice if the League could fill the bill, wouldn't it?

. . . Ken

Here's $50 – I think I will go the whole route. Send me 73 for "your life or mine."

I think a series on building a serious VHF station would be great. Start with 2m complete antennas, converters, transmitters, etc. Then do 432. I really think this would be a goldmine of articles. Get the "Big Boys" to write some of them.

Marshall P. Williams WA5UNL
5429 46th
Lubbock TX

73 has the articles, but they aren't in the form of a series. Might not be a bad idea to think about it, though. Anybody else have ideas?

. . . Ken

Self-Destruction?

I first wish to say that I have subscribed to every Ham publication at one time or another, and I have found yours to be the most interesting. Secondly, I wish to comment on the Great Battle that your magazine has been carrying on for the past several years. I have off and on been reading the letters in your columns and found that most believe that one cannot stand in the middle of the road in the struggle with the ARRL and the fight for individual representation. I believe that the Great Battle has been stalemated by this radical and unfortunate position. Neither side can claim that they have all the answers, or all the supporters, and it seems to me that it is foolhardy to divide a minority into two entrenched factions that are sworn to battle to the death for God and amateur radio. I suppose that if the peoples of the world were split into two groups, then this method would be effective in

deciding which group were to survive. Unfortunately, we are not the world's population, but a minority; and, when the smoke of battle clears, one group or the other will not stand victorious, but both defeated. The remaining group will have been battle-tested, but small, weakened, and obnoxious in the eyes of our "don't make waves" government's opinion, will win their battle without firing a shot. Think! If you wished to destroy a group and their holdings, what better way than allowing the group to destroy itself. No, I am not screaming conspiracy; I am screaming *idiots*. You are the self-righteous lambs, not with the dignity of being led, but taking yourselves to the slaughter.

Judge your position by its results. What are they? Most of those opposed to the ARRL's position wished it to be destroyed and a new and better organization to grow from its ruins. Has this happened? Those who believed that the ARRL's proposals would strengthen the League and elevate the amateur's technical ability should also pause to reflect. Has this happened?

Change! Is that what you want? I sincerely hope so as that is certainly what we are getting. The direction of the change is the unfortunate thing: the decay of a once-proud entity always is unfortunate. I would have much preferred the status quo to suicide, but now I – and others like me – am being dragged along and forced to watch this abomination. Now nothing can stop this change; the impetus is too great. We (and I mean *we*) still can determine the direction of this change. The one great question is how can we accomplish reconstruction and redirection from the throes of self-destruction? After taking inventory the deplorable fact exists that the League is the only recognized agency in existence that still maintains any manner of respect or authority with the government. We need a liaison, and the League must be that liaison. That, regardless of your viewpoint, is a hard and inescapable fact.

What we must do, what should have been done in the beginning, is to change and support the League, not destroy it. If the effort that was put into demeaning the League had been channeled into reconstruction and reenforcement from the beginning, this situation could not have existed. Anarchy cannot exist, if isolated. We should have usurped their authority, isolating the anarchists and making them impotent. We cannot do that from outside the League: it must be accomplished from within. We must regain control of the League and its position of authority and use it for the common good.

The recipe to success is deceptively simple. Join, keep informed, participate, and vote! Above all else we must have patience! Although it may appear like our problems are of a fairly recent origin, starting perhaps around the time Wayne Green brought them to light, you couldn't be more mistaken. Vital organizations don't decay overnight. We lost the League years ago, and it may take years to reshape it again. The question that we all must answer in truth to ourselves is a basic one. Do you want to be a "ham," I mean do you really want to be a "ham" enough to forget about your investments in amateur gear and take time to think and be proud of being an amateur radio operator? Pride? Maybe it is the thing that stabs you in the back when a new acquaintance of yours invites you

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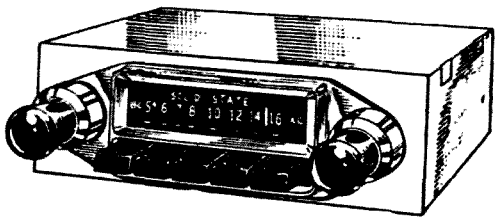
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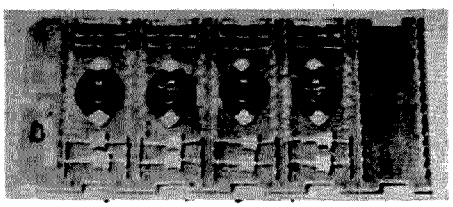


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A3008	914	FP	Dual 2 input gate	1.00
A3002	915	TO-5	Dual 3 input gate	1.00
A3003	923	TO-5	JK Flip Flop	1.00
A3007	3M4-923	FP	JK Flip Flop	1.00
A3005	1M4-925	FP	Dual 2 input gate exp.	1.00
A3004	926	TO-5	Buffered JK Flip Flop	1.00
A3006	926	FP	Buffered JK Flip Flop	1.00

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over to see his ham setup and shows you his CB rig, the thing that's inside that old receiver or transmitter that you keep around for sentimental reasons, or the thing that makes you see your junk as "junque." Pride, or whatever name you can give to that sense of being that once united and made the League strong, we need now more than ever.

If implementation of your wishes is your problem, maybe the new structures, the roundtables that SSB brought upon us and the profusion of traffic nets, can be made to perform double duty. There is always someone on these nets and roundtables who has a definite opinion on how things ought to be run up there in Newington. If you agree with him, why not tell him to do something about it. Support him with your proxy and give him the backing he needs to put some of that QRN he's generating to some good use. Take some of that spare time at the end of the net to inform the net about what is happening inside the League, instead of filling the time with comments from the push, hold, and talk fans.

If you still need some incentive, first think about 11 meters, and then swivel around in that chair, look at your "ham" gear, and try to think of someone you can sell your rig to when you don't have any bands left to operate on.

N. Gary Boucher W3GNR
411 Waupelani Drive
State College PA

Forgotten

We are sorry to learn that Ken has led such a sheltered life and missed the dynamic and growing southeastern section of our country in both his travels and attention. May I bring 73 up to date with the repeater operation in our state?

The Carolina Repeater Society (WB5PLN) operates two repeaters near Columbia which covers a 60 to 70 mile radius to mobiles in the central portion of the state. The 6 meter repeater has a 52.76 input and 52.525 output. The 2 meter repeater has an input of 146.34 and an output of 146.94. Both repeaters are a split system. The two receivers are located on a tower near Edmund and are connected to the transmitter located near Gaston by separate 450 links.

WA4SSJ in Greenville operates a similar repeater with an input of 52.76 and output of 52.525. There is also a .34/94 two meter repeater on each side of us – Augusta, Ga. and Charlotte, N. C. All these systems are open repeaters. We welcome travelers and invite their use of our repeaters and invite our neighbors in the southeast to communicate with us.

Ken Adams K4MOC, President
Carolina Repeater Society
Columbia SC

All it takes is a spokesman. We at 73 don't publish repeater info until we get it. If you know anyone who wonders why his repeater never gets

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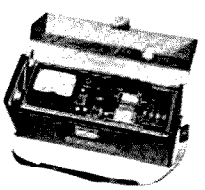
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listed in our directory, ask him how long it has been since he sent the particulars to 73. Squeaky wheels get greased better and more frequently.

... Ken

Bravo!

I have enjoyed reading 73 in the past, but the recent staff additions and the fine FM articles have done the trick! Here's my $12 for 3 years. Keep up the good work in FM! Although I do not always agree with the editorial policies of 73, I find it *does* provide the opinions not found in other ham magazines. 73 is not afraid to "speak up" and I admire that. Bravo!

John S. Cole WA8ZPF
488 Fourth Street
Manistee MI

You may be interested in reading the following comparison and rating of 73 and *QST* magazine, along with my comments and suggestions.

(Ratings are 1—5)

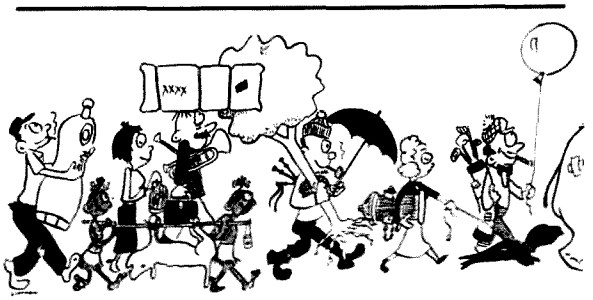
	73	QST
Tech. Articles	3.5	5+
Editorials	5+	2
Ham Ads	2	3.5
Interest	5+!!!	3–4
Overall Rating	5	3.5

As you can see, I prefer *QST* for articles for a purely technical nature, but as far as editorial glimpses of our hobby I prefer your magazine. Although many of your articles start on a technical theme they seldom "follow through" into a thorough discussion of the subject. However, your editorial columns are to be ranked with the best of other nonham magazines such as *Saturday Review* and the like – especially Dave Mann's *Leaky Lines*, which is one of the finest pieces of literary opinion work I have ever seen. I rate K2AGZ and his column an extreme 5+!!!!!

One more important rating:

Humor: QST-0.5 ... 73-5+++++!

Paul Nelson WA5WOE
9773 Oak Point
Houston, TX



If you're moving, don't forget your ZIP code!

73 Readers' DOUBLE BONUS

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- ☐ Linears
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- ☐ Oscillators (rf)
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- ☐ Towers
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July 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7	7	7	7A	7A	14	14	14
ARGENTINA	21	21	21	14	14	7	14	14	21	21	21	21A
AUSTRALIA	14	14	14	14	7B	7	7	7A	7	7B	14	14
CANAL ZONE	21	21	21	14	14	7	14	14	14	21	21	21
ENGLAND	14	14	14	7A	7	7A	14	14A	14A	14A	14	14
HAWAII	14	14	14	14	7	7	7	14	14	14	14	14
INDIA	14	14	14	7A	7B	7B	14	14	14	14	14	14
JAPAN	14	14	14	14	7	7	7A	14	14	14	14	14
MEXICO	14	14	14	14	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	7B	7B	7A	14	14	14	14	14
PUERTO RICO	14	14	14	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	7B	7B	7	14	14	14	14	14	21	14	14	14
U. S. S. R.	14	14	14	14	7	7A	14	14	14	14	14	14
WEST COAST	14	14	14	14	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	14	7A	7	7	7A	14	14	14	14
ARGENTINA	21	21	21	14	14	7	14	14	21	21	21	21A
AUSTRALIA	21	21	14	14	14	14	7	7	7A	7	14	14
CANAL ZONE	21	21	14	14	14	7A	14	14	14	21	21	21
ENGLAND	14	14	14	7A	7	7	7	14	14	14	14	14
HAWAII	14	21	14	14	14	7A	7	14	14	14	14	14
INDIA	14	14	14	7A	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	7	7	7	14	14	14	14	14
MEXICO	14	14	14	14	7	7	7	14	14	14	14	14
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PUERTO RICO	14	14	14	14	7	7	14	14	14	14	14	14
SOUTH AFRICA	7B	7B	7	14B	7B	7B	14	14	14	14	14	14
U. S. S. R.	14	14	14	14	7	7	7A	14	14	14	14	14

WESTERN UNITED STATES TO

ALASKA	14	14	14	14	7A	7	7	7	7A	14	14	14
ARGENTINA	21	21	21	14	14	7	14	21	21	21	21	21A
AUSTRALIA	21A	21	21	21	14	14	14	14	7	7	14A	21
CANAL ZONE	21	21	14	14	14	14	14	14	14	21	21	21
ENGLAND	14	14	14	7A	7	7	7	7A	14	14	14	14
HAWAII	21	21	21	21	14	14	14	14	14	14	14	21
INDIA	14	14	14	14	7A	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	14	14	14	7	14	14	14	14
MEXICO	14	14	14	14	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	14	14	7	14	14	14	14	14
PUERTO RICO	21	21	14	14	14	7	7	14	14	14	14	14
SOUTH AFRICA	7B	7B	7	14B	7B	7B	7B	14	14	14	14	14
U. S. S. R.	14	14	14	14	7	7	7	14	14	14	14	14
EAST COAST	14	14	14	14	7	7	7	14	14	14	14	14

A = Next higher frequency may be useful also.

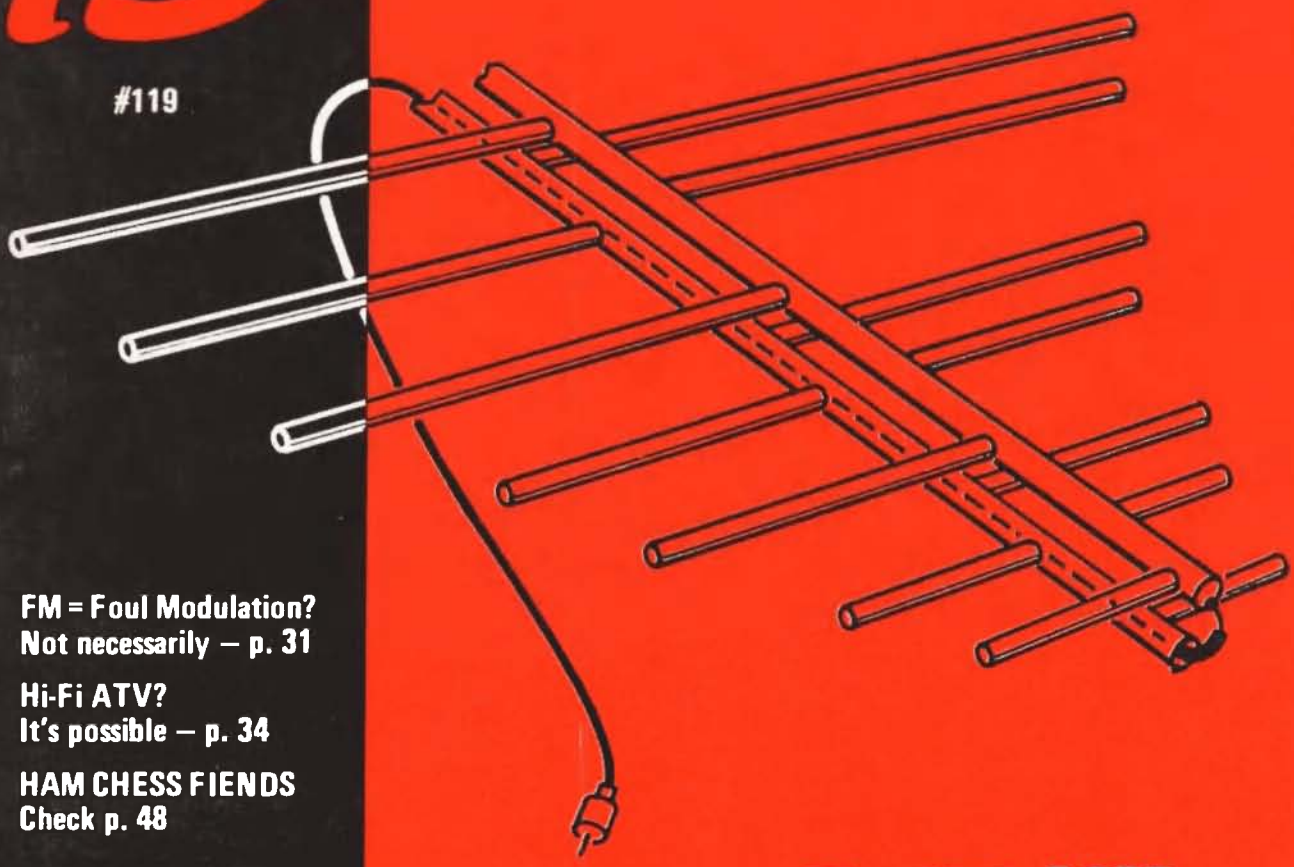
B = Difficult circuit this period.

AMATEUR RADIO 73

#119

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August 1970

Ham Log Periodic Antennas!



21–450 MHz
Exhaustingly brief details p. 45

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Not necessarily – p. 31

Hi-Fi ATV?
It's possible – p. 34

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Check p. 48

2M Xstr Xmtr?
Yup – p. 54

$2.85 VHF Wattmeter?
Would we lie? – p. 20

MORE-MORE-MORE

New Study Series:
Getting your
General ticket

73 MAGAZINE

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#119 August, 1970

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Amateur Radio News Page

Aug XIXLXX | Monthly Ham News of the World | 73 Magazine

HAM'S QSO SAVES LIFE IN COSTA RICA

Radio-TV Men Watch as 'Mercy Mission' Drama Unfolds

Thanks to the efforts of a few conscientious hams, an alert newspaper, and a mercy-minded airline, a Costa Rican hemophiliac was saved from what doctors said was "sure death." The incident was a highly dramatic example of the importance of ham radio to a community.

The international "mercy mission" was touched off by Long Beach, California Amateur Nate Brightman K6OSC, who received an urgent message from a Tuna clipper fishing off the coast of Mexico. The vessel's radio operator, Rodriguez Beeche TI8RBL, was relaying a message from Dr. Herman Weinstock in San Jose, Costa Rica, asking Brightman to arrange an immediate shipment of Hemophil, a blot-clotting agent produced by Hyland Labs, a Glendale, California firm.

Dr. Weinstock related, via ham radio, that his patient, 24-year-old Ed-



A helicopter furnished by the L. A. Sheriff stood ready in Glendale to pick up a vital serum and rush it to a waiting Pan-Am jet at the L. A. International Airport.

arrived at the airport with the drug, about a half-hour after the Pan-Am jet's scheduled takeoff.

The Hemophil was delivered on time, and the patient responded so well to the medication that an operation

dent from the outset. Dr. Weinstock's messages were phone-patched out by his ham brother, Salomen Weinstock TIZWC. Louis D. Arce TI2LA provided postdelivery information from San Jose for Stateside newsmen. Pablo

CITIZENS PROTEST HAM RADIO TOWER

While a ham in Long Beach worked to save the life of a dying man in another part of the world (see headline, this issue), another amateur in a neighboring community was being legally "assailed" by public-spirited citizens who were protesting installation of a 55 ft tower.

Tom Rothwell, an Extra class ham of Los Alamitos, California, had applied for and received permission to construct the tower, but residents in the area appealed the decision. The city council called a public hearing after reading a petition signed by 63 townspeople.

In defense, the amateur radio operator stressed the importance of ham radio during natural and man-made disasters when other means of communication are disabled. He asserted, logically, that his installation could prove vital to the community.

After listening to protests from most of the 45 people present at the hearing, City Attorney Jack Parker ordered a continuance so the council

uardo Castro, required an immediate operation for bleeding ulcers and would have "no chance for survival" without the coagulant.

In contacting Hyland Labs by telephone, Brightman learned that the firm's supply of the drug had been depleted, and that the earliest time a new batch would be ready was the following morning – but not quite in time to catch the only available plane for Costa Rica.

Recognizing that a certain amount of pressure would be required to coordinate the various elements of the situation, Brightman called the local newspaper, the Long Beach Independent Press Telegram, and asked help in getting the drug to its destination.

With the news media tuned in, the ball started rolling, as TV channel 9, radio station KFWB, and the Press-Telegram provided heavy publicity. The newspaper called Pan-Am World Airways' New York office and obtained the authorization necessary to hold the Costa Rican flight long enough to get the drug aboard. Then it arranged for a Los Angeles Sheriff's helicopter to fly the drug the 20 miles from the lab to the airport as soon as it was produced.

Newsmen and TV cameramen were standing by when the helicopter was found unnecessary.

A 73 reporter talked to Nate Brightman and learned that several amateurs had been involved in the incident. Fonseca TI4PF and George (TI2IT) also provided message handling and phone-patch services during the overnight intercontinental emergency.

Food for Thought: Without a similar facility, Long Beach operator Nate Brightman might not have been in a position to put into motion the chain of events that saved a life. If Brightman's neighbors had been as short-sighted as Rothwell's, what would have happened to the hemophilia victim in Costa Rica?

DARC President Visits U.S.

Karl Schultheiss, the president of the DARC, will be visiting the U.S. in late August and early September, staying with WA2ELA in Dewitt, New York and traveling from there. Perhaps your club could arrange for Karl to visit? Write to James Kirkgasser, 105 Haddonfield Place, Dewitt, N.Y. 13214 and make arrangements.

Polish Ham's Death Felt Worldwide

by W4WFL

Amateur radio lost another pioneer with the recent passing of Jan Ziembicki (SP6FZ).

Active as early as 1921 with the callsign TPAR, Jan's interests embraced all aspects of amateur radio. He was one of the earliest experimenters on the VHF and UHF frequencies and by the mid-thirties was experimenting with television transmission.

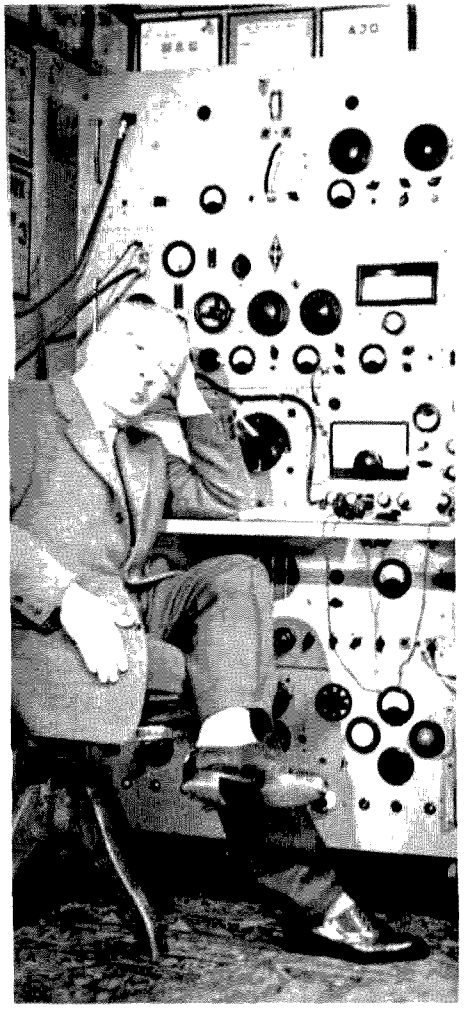
Following the allocation of international prefixes, Jan operated under the callsigns SP5AR and SP1AR until the outbreak of World War II. After the war he was unable to obtain a license until the mid-fifties when he returned to the air as SP6FZ.

Jan quickly established himself as a leading DX'er, garnering most of the important awards, including DXCC and WAZ.

His rig was completely homebrew and constructed from a wide variety of surplus, commercial, and homemade parts. It covered the bands from 80 meters through 450 MHz, phone and CW.

Jan was a doctor of engineering and in recent years he was associated with the University of Warclow where he was involved in the design and application of electrical and electronic devices for use in cardiology and other areas of medicine.

His passing is a heavy loss to family and friends and to amateur radio.



Scholarship Set for Student Hams

The Foundation for Amateur Radio, Inc., a nonprofit organization headquartered in Washington, D.C., announces its intent to make the annual award of the John Gore Memorial Scholarship for either graduate or undergraduate study. The Scholarship pays $500 for the academic year. Upon reapplication, it is subject to being renewed for succeeding years.

Licensed radio amateurs who intend making a career in electronics or related sciences may now request the application for covering the academic year 1970–1971. Requests should be addressed to Chairman, Scholarship Committee, 8101 Hampden Lane, Bethesda, Maryland 20014. The award will be made during the month of December 1970. Receipt of applications for the award must be received by the close of business on 31 October 1970.

To be eligible for the award, applicants must have completed at least one year in an accredited college or university and must be enrolled in a course of studies leading to a degree. They must also be radio amateurs holding a valid FCC license of at least a General level.

MARS OPS GET SSTV DEMO

The enlisted men's service club at Andrews AFB was the scene of a slowscan TV demonstration in which 18 Air Force MARS operators were in attendance. Dr. Theodore J. Cohen (W4UMF) reviewed the broad field of slow-scan communications, beginning with a discussion of bandwidth–time considerations, and continuing on through equipment construction, color transmission, and computer processing of slow-scan pictures. A live demonstration of a slow-scan monitor, using taped pictures as a source, topped off the evening. Among those in attendance was the recently appointed Chief of Air Force MARS, Capt. Jan P. Huggins (WB4ONK). Col. Paul Ridenour (W8KDS) hosted the meeting.



Dr. Theodore J. Cohen, W4UMF, addressing Andrews AFB Radio Club.

DX NEWS

by W2NSD/1

GUS SWAMPED. . .ALMOST!

After three days of operation on Geyser Reef as AC0A/GR, the high winds and heavy rain took their toll. When two drums of gasoline floated away Gus had to give up temporarily and make the hard trip back to the Comoro Islands for more gas. The reef is very difficult to get on and there is only a very small place for a station to be set up. . .and even that gets splashed

Trevor 5W1AR has been active from Western Samoa, bless him. He is living in the same house as 5W1AZ and, I believe, using the same rig. This is the rig I used when I visited there back in 1966 and racked up a couple thousand contacts almost overnight. Trevor was my first contact with 5W1. . .the problem was that the previous op had a small circle of friends that he worked, and that was about it.

Market Reef has been busy

More activity from Qatar (pronounced gutter) as Tom MP4BHH brings a rig down to Dave MP4QBK and leaves it with him in late June. AP2KS is weak, but in there on 20.

5T2ITU was doing well during a May contest, though Mauritania is not extremely rare these days, what with 5T5ADand lists by PY2PE. Even old familiar calls like KM6 seem rare these days. KM6BI (Glen) called in the other day to say hello, my first KM6 is ages. KW6EJ (Jack) has moved down to the Caroline Islands now and can be heard reguaarly as KC6EJ. Those strange calls that turn up during contests make the ITU prefix list handy (73,July 1970).

Around The Amateur World

Excerpts from IARU Region I News

CZECHOSLOVAKIA. Czechoslovakia has nearly 3000 amateur radio stations of which about 500 are club stations with registered operators and shortwave listeners. Besides the activity on HF and VHF bands there is amateur radio activity in connection with fox hunting, high-speed code contacts and the construction of electronic equipment. The *Central Radio Club of the Czechoslovak Socialist Republic* has an office in Prague which carries out the work of the QSL Bureau, certificates and awards and contest organization. The Novice license allows operation on the 1.8 and 145 MHz bands with a maximum input of 10W. The full license has three classes: Class C, 25W input on restricted bands; Class B, 75W input on all bands and all types of emission, and Class A, 300W input on all bands using all types of emission. The first Czech DX club was recently formed by a group of amateurs from Slovakia. Dr. Harry Cincura OK3EA was elected club president and OK3IR became secretary. OK3-DX club has 28 full members and 37 others, to promote interest, a weekly DX bulletin (DX-NT) has been established. The editor of DX-NT is Joko Straka OK3UL. Dr. Cincura was a member of the Czechoslovak delegation to the 1969 Region I Conference at Brussels. This news of the formation of OK3-DX was sent by Tibor Polak OK3BG.

EAST AFRICA. Please note that the address of the RSEA QSL bureau is Box 5681, Nairobi, Kenya. In addition to exhibiting at Electra 70 the RSEA will again be providing communication facilities for the East African Safari.

GERMANY. During 1969, 179 reciprocal licenses for operation in

by the larger breakers. The propagation conditions, as accurately forecast in 73, were dismal on 15 and 10 meters and forced Gus to spend most of his time on 20, holding forth on 14,000.000001 or so. The phone operation was around 14,106 kHz. Conditions were a bit better on his second stint, fortunately.

ZB2A (F Gordon) has been adding to the 20 meter pileups on weekends. He recently decided, with the help of his QSL manager (WB9WBU), to try the "list" technique. It worked well and the contacts went a lot faster than the usual super-tailend system, with stations tailending each other for minutes at a time to be sure and be the last to transmit.

While operating from JY1, I never let the tailenders get going on me, but I did run into problems with downright callous operators trying to get through no matter who they had to squish to make it and no matter who I asked to transmit. Split frequency helped a bit with this, happily I thought to try getting some of the stronger signals to make up lists for me. This was very fast – the fastest of all.

SVØWU puts through a regular signal from Rhodes, which counts for the Dodecanese Islands, a separate country from Greece. Ike works for the Voice of America there on Rhodes.

9H1G (Joe) and 9H1CE (Bert) have been active recently from Santa Lucia in Malta. Bert is a bit weak with his SB33 and dipole, but Joe runs 300W into a three-element beam and has a substantial signal. 9H1CD is also active. Another rare one in the Mediterranean area is Morocco. (CN2BS (Chris) is doing what he can there to help. OD5BZ (Bob Adams), by far the most active station in Beirut, has now packed up and gone back to W8-land. We will all miss his strong signal. By the way, if you find yourself in Beirut (and who doesn't find himself in Beirut now and then, right?) don't miss the Al Barmaki restaurant. Bob showed me this one and it is great!

again. . .third time since it passed muster as a country. This time ops are OH2BH (Martin) and about ten others – the call is OJØDX. QSL to Angerroti 8B17, Heisimkin 32, Finland.

There are many hints that some OHs will make it down to ZA for the first operation from there in a long time. . .or is it ever? DL7FT was collecting money to go, but nothing came of it and no answers to letters to Frank asking about his plans, the money, etc.

King Hussein has been off the air for a few weeks obviously as a result of the headline problems that have developed in his country. The QSLs have been coming through the bureaus for his contacts and mine from JY1. If you haven't gotten your card yet you either haven't QSL'd to Box 1055, Amman, Jordan as requested, or you have been too cheap to send an envelope to your QSL bureau, or both. I have a personal and vested interest in His Majesty solving his political problems. . .I want to get back to Jordan for another visit perhaps this winter, and I am hoping that an introduction from the King will help me to talk with powers in neighboring Arab countries so I can sell amateur radio.

VR4CG George has been active from Honiara (Box 310) in the British Solomon Islands. I think he must be rare because he is the first VR4 I've heard, ever. He was on 14.231 with a nice S7 signal and not-too-big pileups at 1300Z on a Sunday.

WØMLY (Dick), who runs the Antenna Mart out in Rippey, Iowa, doesn't miss much going on, and has a new one up his sleeve that he hints about, but won't explain. He claims it is new, will count, and that he has the license for it. All he needs is the money, but with collections for DL7FT to go to ZA, Gus to go all over the place, and such, he decided to sit still for a while. Donations have been noticeably harder to get lately, a phenomenon attributable to what some call the "Miller" effect.

ZZ2ERS (PY) says QSL to WB9BWU. ZV7APS did well in the contest and is also from Brazil.

Now that Robby is relatively inactive, even the 5Z4 prefix has rarefied. Chuck, up in Kitale, has been active as 5Z4KM, easing some of the pressure. But I noticed when I operated from 5Z4ERR a couple years back that the pileups were substantial, and again a few weeks ago when Gus stopped there, the pileups were going again. 5Z4 is "medium rare."

LZ1KSZ (Michael) in Stara Zagora (I thought I would mention the city since it has 100,000 population and I'll bet you've never heard of it) started DXing when he was 15, seven years ago. QSL to Box 73. He tells me that the active LZ1s in the club are DG, DK, DO, DL, DJ, DZ, KP, KGZ, KFZ. Most of them are on CW.

VR1L (Bob) is on Ocean Island, one of the Gilbert & Ellice Islands. He most definitely QSLs, through W6NJU. Bob was a new one for me. I missed him one night when he was in QSO with VR1). . .wouldn't that be a nice roundtable to break?

The activity in Turkey has been growing recently, after many years of very sparse contacts. QSL to TA3HD (Hal) vis K3ZPU. Father Moran 9N1MM is on quite often, if you think to point your beam up thataway. He has a good signal and is active enough, along with Jinny, to keep Nepal only medium rare. Afghanistan doesn't come through all that often, but I've contacted a number of fellows up there recently. Probably the most active for me has been YA1GNT (Ed).

Are there any valid contacts being made with China? I doubt it. I suspect that the next BY you hear should be ignored. . .but I'll bet you'll work him "just in case."

I see that K1OTA (Ken) is expecting to be active from 3A2 (Monaco) July 23–27, C31 July 30–Aug 4, LX Aug 6–9, 9H1 Aug 13–16, 3V8 (Tunisia) Aug 21–23. That sounds like a ball.

Germany were issued by the DARC office of International Affairs. All applications for permission to operate in Germany should be sent to DARC International Affairs, Muhlenstrasse 27, D-5601 Doberg, German Federal Republic.

INDIA. During the recent CCIR Plenary Conference held in New Delhi, the Amateur Radio Society of India held a reception for delegates. Among those attending were Brigadier L. King VU2AK, and M.G. Karnik VU2CK, president and vice president of the ARSI. The visitors included RSGB president Dr. John Saxton, and Jack Herbstreit HB9AJI, director of the CCIR. During the meeting a special station (VU2ITU) was in operation.

REPUBLIC OF IRELAND. The address of the official QSL bureau managed by the National Society, the IRTS, remains as 24 Wicklow Street, Dublin 2. Visitors to the republic may obtain, without charge, a temporary license for up to 30 days' operation in any year. Applications should be sent to Department of Posts and Telegraphs, (G.B.) Radio Section, Hammam Buildings, O'Connell Street, Dublin 1. Applications should be made at least one month before the proposed visit. The following information should be given:

1. Date of commencement, and duration of visit.
2. Band or bands to be used.
3. Type or types of emission to be used.
4. Brief details of equipment.
5. If mobile, give make and registration number of vehicle.
6. For fixed operation, give QTH.
7. Holders of UK licenses should send photostat copy of *first page only* of their license or their mobile license.
8. European licensees, send photostat copy of license.

Visiting amateurs will only be afforded those facilities to which their home license ordinarily entitles them.

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. Include your check with order.
We cannot check into each advertiser, so Caveat Emptor. . .

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd PA 19004.

RBB-RBC MANUALS, New $5, Used $4. OS-8 Oscilloscope Manual $3. Some QST 1929, 30, 31 etc., Radio 1939, 40 41 etc. Write for list. James W. Holloway W6LFL, 2027 Harton RD., San Diego CA 92123.

FOR SALE OR TRADE National NCX-500, AC500 Power Supply, 100 Kc XT1. Marker — 6 mos. old. Sacrifice $335 complete. Will trade for video tape recorder — going strictly 2 meters. K9GJM, 1113 Laurel, Highland IL 62249.

"TOWER HEADQUARTERS!" 11 brands! Heights aluminum 35% off! Strato Crank-ups-low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co., Stanley WI 54768.

COLOR ORGAN KITS $3.25 up. IC Power supplies $2.75 to $8.50. Computer grade electrolytic capacitors $.35. YMTR transistor TRW PT3690 $4. Catalog. Murphy, 204 Roslyn Ave., Carle Place, NY 11514.

NOVICE CRYSTALS: 40—15M $1.33, 80M $1.83. Free flyer. Nat Stinnette Electronics, Umatilla FL 32784.

HT37 $175, SX101A $165, Linear Systems. 500 D.C. Supply $65, Waters Antenna 80 — 10 meters $35. R. Stanzak 47—6A Norstar Blvd. Liverpool NY 13088.

WORLD RADIO'S used gear has trial-terms-guarantee! HX30 (6M-SSB) - $199.95; RX1 - $149.95: Swan TV2 - $199.95; 350 - $279.95; DuoBander 84-$104.95; T4X - $299.95; HQ110C - $139.95; HQ170C - $179.95; NC300 - $139.95; Galaxy 5mk3 - $279.95; SB33 - $189.95; SB34 - $249.95; GD104 (mic-stand) $19.95. Free "blue-book" list for more. 3415 Broadway, Council Bluffs IA 51501.

FM PICNIC Sunday August 2, near Angola, Indiana. Big prizes, free flea market, entertainment for the ladies and kids. Picnic grounds, campsites, boating, food, soft drinks available, rain or shine. Call in freq. 146.34/146.76, 146.94, 52.525. For information contact Fort Wayne Repeater Assn., Box 6022, Fort Wayne IN 46806.

FM SOLID STATE ICE TRANSCEIVER on 146.34, 146.76, 146.94 mc, like new $150. PMR-8 Receiver $35. S38 Receiver $25. W.Davis 4434 Josie Avenue, Lakewood CA 90713.

POLYCOMM PC 62B: 6 & 2 mtr. transcvr. Built in AC, DC, squelch mike, and separate VFO. with 7 element beam: xclnt: $175 WB6UWJ (213) 287—4423.

SWAN 250C with noise silencer, mint condition, cost new $486.00, used 23 hours, now $350.00, plus shipping. Globe vox 10 $11.00, Drake low pass' filter tv-1000 $11.00, Ameco low pass LN2 $5.00, new National Schools 3 band receiver $20.00. Kenneth Massie, 115 Woodlawn Drive, Ironton OH45638.

FOR SALE: SSB-CW Rig. 2kw PEP. 80 thru 10 meters. SASE for specs, pic. $650 or best offer. G. Powerll, Rt. 11, Beattyville KY 41311.

THE FRRL HAMFEST, will be held at Phillips Park in Aurora, Illinois, on August 23. Free coffee and donuts will be served from 9:00 to 10:00 AM. Advance tickets $1.00, $1.50 at the gate. Talk-in frequencies: 145.35, 146.94, 3.94 Mcs. For further information, contact, Tom Rogers, WA9WBV, Box 323, Oswego IL 60543.

QSL CARDS? Samples 25¢. (deductable). Sakkers, W8DED, Holland, Michigan. (mention "73" magazine).

FOR SALE: RCA WR99A Crystal Calibrated Marker Generator $150. Never been used, new Bands. Ralph M. Williams, Box 372, Dixfield MA 04224.

INSTANT SUPER JUNKBOX: Must sell mine. Write for list. R. Stinaff, 206 Magnolia Terrace, Pendleton SC 29670.

WANT TO OPERATE, 6 or 2 — need equipment — cannot afford it — if you have any spare equipment, please let me know. WA8ZHK, P.O. Box 365, Chagrin Falls OH 44022.

"HOSS TRADER ED MOORY" says he will not be undersold on Cash Deals: Shop around for your best cash price and then call or write the "HOSS" before you buy! New Equipment: Factory Warranty: Early Model Swan 260 Cygnet with microphone, ($435.00) Cash Price $339.00: New Gonset GSB 201 MkIV Linear, 2000 Watts, ($495.00), Cash Price: $295.00: New Swan 350C, ($420.00), Cash Price $339.00: New Rohn 50 ft. Foldover Tower Prepaid, $199.95: New Mosley Classic 33 and Demo Ham-M Rotor, $198.00: Used Equipment: R4, $259.00: L40B, $549.00: TR-4, $419.00: 500C, $375.00: 75A-4, $319.00: HT-37, $169.00: Two Locations: Moory Electronics, Phone (501) 946—2820, P.O. Box 506, Dewitt AR 72042; Moory Electronics. Bill Davaul (W5FQX), 415 W. 33rd, N. Little Rock AR.

JOHNSON KILOWATT LINEAR AMPLIFIER: $250.00; 32V-3 Collins transmitter $175.00; VHF-152-A $25.00; DB-22-A $25.00; BC-22-T, power, book, $50.00; HQ-129-X $40.00; HRO-60 $150.00; NC-190 $110.00; SX-110; $75.00; Heathkit GR-81 $15.00; Morrow CM-1 Conelrad $10.00; Tape Recorder Pentron 9T-3C $24.00; Ameco CB-6 Converter $10.00; Ameco PS-1 Power $8.50; Back issues CQ, QST, IRE, AIEE, RADIO, WRA etc. All items good working condition, applicable manuals or diagrams furnished, everything FOB Indianapolis. Wanted: 30L-1 or SB-200 Linear; Write requesting detailed listing, descriptions. Telephone evenings only five to nine EDST (317) 291—4444. W9DPL Howard Severeid, 3602 West 71st St., Indianapolis IN.

DTL INTEGRATED CIRCUITS: Guaranteed New — gates 70¢, buffers 80¢ F/F 90¢, dual F/F $1.15 — add 20¢ postage. Also other inexpensive parts. List & prices from Mitch-Lan Electronics Co., Dept. 970, P.O. Box 4822, Panorama City CA 91402.

FOR SALE: Swan 350 with VOX & 117XC P.S. Excellent condx. $275.00. . .SBE-34 & SB-2LA. Linear in excellent condx. 34 in good condx — needs a little tuning. . . $200.00. Will Ship prepaid. Send M.O. Chal Shrader, K5CYE, 5914 Palo Alto Dr., Little Rock AR 72209. Tel: 501—562—6103.

Hamfests and Other Happy Occasions

New York

DeMolay from the State of New York will be operating a station from welcome. Assitance with reciprocal licenses willingly given. Further information and skids available from Alan

LISTING SERVICE — Gear to sell? Need rig? Sellers $1.00 Lists information year. Buyers free. SASE brings details W8TXX listing service, Box 1111, Benton Harbor MI 49022.

CERAMIC 7289 (3CX100A5) tubes. Replace 2C39. $3 each or trade for 2MTR FM gear. W4SOD, Box 73, Folly Beach SC 29439.

ELECTRONIC ORGANS, solid state, spinet, send SASE for particulars, Lloyd G. Hanson W9YCB, RR 2 Box 52A, Angola IN 46703.

END CARD PROBLEMS. Frame, protect, store or display 200 QSL's in 20 card plastic holders for $3.00, prepaid and guaranteed. Tepabco, Box 198, Gallatin TN.

GREENE... center dipole insulator with...or...without balun. See November 73, page 107.

RTTY GEAR FOR SALE, List issued monthly, 88 or 44 MHy torriods 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland CA 94610.

HELP — Need someone qualified on solid state rcvrs, have DAVCO DR—30 with no sensitivity, replaced bad rf FET but no improvement, set not butchered have manual — Tom Gillam, KØUIW, Cam Ranh area exchange, APO 96312.

DRAKE 2B LIKE NEW — $135; Motorola D33GGV (Twin V Series) with xtals-$55; 2 meter commercial cavities transmit and receive-make offer. Shepard, Limeledge Rd., Marcellus NY 13108.

WARREN AMATEUR RADIO ASSOCIATION(W.A.R.A). 13Th Annual Hamfest, Sunday, August 16, 1970 at new location. New Trumbull County Fairgrounds, 2 miles north state, Route 305 on Bazetta Road just west of Mosquito Creek Reservoir. Registration begins at 1000 hrs. Mobile talk-ins on 3940 KHz and 145.

GET YOUR "FIRST!" Memorize, study — "1970 Tests-Answers" for FCC Class License. Plus "Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

BUY, TRADE, SELL: Used amateur receivers. Steven Kullmer, Evergreen Hatchery, Dysart IA 52224.

50W AM XMTR, 2M (lettine 242) rack mount, $35; Tecraft 2M converter as is, $10; Heathkit vibrator power supply (GP 11), $5; WRL VFO 755, $15; B&W T—R switch (380 B), $10; seven foot relay rack, steel, $10. Everything: $80. (Ship your expense.) Dahlstrom, 3345—1 Gila Bend, NAF, EL Centro CA 92243.

FULL 75M. PHONE COVERAGE, or any 250 KHz with Hustler 4-BTV and other verticals. Cast aluminum adapter mounts up to five top-loading resonators. Adapter only $7.95 US postpaid. Request details or see article "Two on Top", 73, May 1969. PAL Marketing, P.O. Box 5187, Santa Monica CA 90405.

SAROC, January 7—10, 1971, Flamingo Hotel Convention Center, Las Vegas, Nevada. Sponsored by Southern Nevada ARC, Inc., Box 73, Boulder City, Nevada. Advance registration $14.50 per person accepted until January 4, regular registration at door, includes Flamingo Hotel Late Show and drinks, Sunday breakfast, coctail parties, technical seminars and meetings ARRL, DX, FM, MARS, QCWA, WCARS-7255, WPSS-3952 and WXXBA. Ladies Program. Flamingo Hotel SAROC room rate $12.00 plus room tax, per night, single or double occupancy January 3 thru 12, 1971. Mail accommodations request to Flamingo Hotel. Mail advance registration to SAROC. W7PRM, Club President. W7PBV, SAROC Convention Chairman.

FOR SALE: SB 200 excellent $175 K6SUZ Los Angeles CA 90048; (203) 731—2561 day, 938—4003 ev.

the 3rd annual state convention entitled the "New Era," being held August 27–30 at Cornell University, Ithaca, N.Y.

WB2WVY will be operated by DeMolays and will be on as much as possible. WB2WVY can be found on or around the frequencies listed below:

CW	Phone
3.725	3.925
7.175	7.260
21.150	21.355

A special QSL will be sent to all stations working WB2WVY during the convention. Send all QSLs to Marsh Gosnell WB2WVY, 11 Orchard Circle, Suffern, N.Y. 10901.

Nevada

The Sierra hamfest will be held Saturday, August 22, at Mormon Station Historic State Monument at Genoa, Nevada just off Hwy 395 south of Carson City.

Illinois

The Vermilion Country ARA will hold its 2nd annual hamfest on August 30, 1970 at Douglas Park in Danville, Ill. There will be door prizes, hourly drawings, and the main drawing at 3:00. Donation: $1. For further info write Tom Stover WA9ULI; 1611 N. Vermilion; Danville, Ill. or call 217–446–3293. Talk-in, by the way, will be on 3.925, 7.260, 50.4, and 146.94 FM and 147.3 FM.

England

GB3WRA, operated by a group of local radio amateurs, will be active from the 24th annual Wycombe show on the Rye. High Wycombe, Bucks, England, Saturday, September 5. Operation will be on all bands, 160–10 meters. All contacts will be confirmed by a specially printed QSL. The Wycombe show is a typical English country show which displays all aspects of English country life. Any Ws visiting the area will be especially C. Butcher G3FSN. 70, Hughenden Avenue, High Wycombe, Bucks, England.

Nebraska

Again this year the Lincoln, Nebraska Amateur Radio Club will operate a special events amateur radio station 24 hours a day from the Nebraska State Fair Grounds in Lincoln, September 3 through September 9, inclusive.

DX contacts will automatically be QSLed via bureaus. Stateside contacts must send SASE to WØYOY, 3030 Shirley Court, Lincoln, Nebraska 66507. A special QSL card for the occasion will be used.

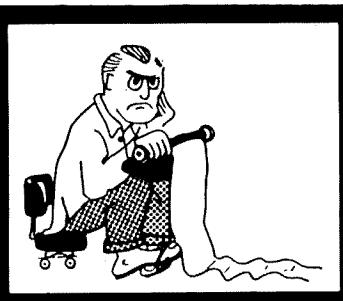
Pennsylvania

The Mt. Airy VHF Radio Club, Inc. will hold the annual picnic and family day on August 9, at the Fort Washington State Park in Flourtown, Pa. In the past, hundreds of hams have attended this event.

A big feature is a drawing for door prizes, some of which are donated, and some purchased by the club. There is one drawing for prizes of interest to hams, and others for women and children.

Washington

THE PUGET SOUND COUNCIL OF AMATEUR RADIO CLUBS will again issue a Washington State operating achievement award signed by Governor Daniel J. Evans, for contacts made during Washington State Amateur Radio Week, September 6th through 13th. Out-of-state amateurs must contact ten Washington hams, and in-state amateurs must contact 20 other Washington hams during this week. Send list of stations worked, their locations, dates of contacts, your name, call, and address to Puget Sound Council of Amateur Radio Clubs, 12306 80th Avenue East, Puyallup, Washington 98371.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

The ITU Problem

Those of you who have been following my editorials down through the years will find this piece a bit repetitious, but perhaps thought provoking.

The most important result of my visit to Jordan was not the contacts that I made or even the setting up of that country with an amateur radio service, it was the vote at the ITU that amateur radio will have from Jordan. Amateur radio has scant support from the African and Asian countries and needs every vote it can get from them.

The source of our amateur frequencies, as I am sure you know by now, is not the Federal Communications Commission, but the International Telecommunications Union in Geneva. The ITU has little organization in itself, being made up mostly of representatives of the many countries of the world who get together in Switzerland every so often to agree (and disagree by way of footnotes in the articles of agreement) about all matters having to do with international communications.

The last ITU conference which was scheduled to take up reallocations of the amateur bands was in 1959. Both John Huntoon and I had the honor of attending this conference as representatives of amateur radio. The only other such representative from our country was W1BUD, but he was very "sick" at the time and was unable to participate much. The allocation of shortwave frequencies was set aside at this conference, leaving the fate of our bands to the next conference which was expected to come along in the mid 60s.

The emergence of many African nations upset the balance of power in the ITU, shifting it from the European countries to the African–Asian countries, with the result that further conferences of the ITU were blocked at every turn by the Europeans. When you consider the decimation of the amateur frequencies proposed by some of the African–Asian countries at the 1959 conference, the delay has been most fortuitous for us.

Since no country has been able to develop its electronics and communications without a healthy amateur radio population to provide the technicians and engineers, we have a terribly important message for all the emerging and developing nations. . .push amateur radio and push it hard or else be prepared to take a back seat to those countries that do. It is reasonable . . .it is logical. . .and the proof is plain to see: those countries that have encouraged amateur radio have been able to develop because they have engineers and technicians to provide the communications which are the most basic ingredient of development.

I do not believe that it is any accident that the industrial development of most countries is parallel to the number of radio amateurs they have licensed. Obviously it is of extreme importance to get this message to the leaders of the emerging countries. Has anything much been done to do this? The answer, as you again know, is a sad no. . .little has been done.

A man of stature is needed for this task. . .one who can not only get in to see the rulers of these countries, but one who will be listened to when he gets there. It is extremely unfortunate that Herbert Hoover Jr., the past president of the ARRL, did not undertake such a goodwill and promotion trip. The money was there for it – $100,000 was set up for just such a thing – but for some reason it never came about. About the only other radio amateur of such an international stature is Senator Barry Goldwater, but I'm afraid that his work in Washington may preclude his setting out on the long and difficult trip that is called for.

I hope that His Majesty King Hussein will not mind my mentioning him, but he quickly grasped the importance of amateur radio to the development of his country and moved immediately to set up the hobby there. I am in hopes that through his understanding and friendship I will be able to visit some of the other neighboring Arab countries and try to set them up with a healthy and expanding amateur service. This will not only help the countries involved, but it will give us a good guarantee of the votes that we desperately need in Geneva.

Unfortunately, I have neither the time nor the money to even make a decent try at promoting amateur radio in but a small percentage of the countries where the effort should be made. I enjoy this sort of thing, but until subscriptions come in a lot faster and advertisers consider it a

lot more important to support 73 than they do now, I'm busy paddling upstream for all I'm worth just to stay in one place. As soon as I rest for a day or so the falls just downstream come closer, if you'll excuse the metaphor.

I hope that I can mention the ARRL at this time without some readers feeling that I am tearing it down. The ARRL, for all of the good things that it is doing, is not yet perfect. . .I hope that even the most prejudiced Leaguer will agree to that. This means that there are areas where some improvement can be made. Is it destructive of me to point these out?

Since the ARRL has set aside $100,000 for the defense of our amateur frequencies it seems logical to me that it is up to them to make a definitive move in this direction. Their position as the national society for the U.S. and their control of the IARU would seem to automatically elect them for this position. They have expended $37.586.48 (according to the last ARRL report) towards this goal during the last few years, though I haven't yet seen an accounting for it. If you are able to get an accounting I would appreciate your passing it along to me. I'm sure that this money was not just spent on vacation trips by the HQ brass. But I'm not certain. Unaccounted large sums like that worry me. No public corporation would be able to hide something like that from its stockholders, so why should ARRL be able to sweep it under the carpet.

The problems at 73 have prevented me from getting over to visit and talk with the current secretary general of the ITU. I did manage to talk quite a bit with two previous secretaries general and found them both very interested in the idea of developing amateur radio in the backward countries as a key means for getting technicians and engineers in those countries. I proposed that the ITU establish a simple set of amateur radio regulations for application in small countries and this was in the works with the last secretary general. This would in essence put the prestige of the ITU behind amateur radio and help our hobby to expand. I am sure that this could be set in motion with the new secretary, if someone could sit down and put the proposition to him.

The ARRL board of directors has been peculiarly silent about this responsibility of the League. This is hardly a problem that can be ignored or just not faced because it is difficult. Since HQ seems to have done little on its own initiative, it is up to the directors to force the HQ boys into action. And it is up to you, the members, to force the directors into action. The next time your director shows up at your club, ask him for an accounting of the $37,000. . .HQ certainly hasn't kept that much money a secret from him. . .and exactly what the League proposes to do about getting votes at the ITU. . .and, incidentally, why he did absolutely nothing at the last board meeting about getting even one man in Washington as a lobbyist for amateur radio!

As long as the League has a net loss each year, even though it is minuscule, it is simple to avoid both tax problems and demands from the members for added services such as public relations, lobbying, etc. The loss last year was, as usual, quite small, less than $50,000 on a turnover of well over $1.5 million. It was also quite unnecessary. There is some $500,000 sitting around doing very little except turning into dollarettes that could be used for the promotion and furtherance of amateur radio. There are also any number of ways that money could be saved, as I am sure your director will have to admit if you corner him, which would provide funds for the benefit of our hobby.

While you are asking your director questions, there are a few others that you should bring up. For instance, if you read the annual report you will find that the publication expense for QST last year ran an average of $32,666 per month. That may not sound too bad, considering the costs of business today, but I will tell you that I could put out the same number of copies with the same number of pages for just about half that. $15,000 a month or so is being blown somewhere and you deserve to know who is getting all that money and why.

Part of the loss is because QST is just a bit bigger than the other three amateur magazines. This little bit extra means that QST will not quite fit on the modern presses and thus has to be run in smaller sections. This increases the cost greatly.

Undoubtedly QST's change to doing their own typesetting will bring about some savings for this year over last. But why was QST the last ham magazine to put in the IBM typesetting system? 73, by the way, was the first. Ask your director about this.

You might ask your director why QST is ten years behind the times in the paper it is using too. The ARRL could save thousands of dollars a year by changing to a more modern type of paper. The paper manufacturers have not been sitting idle; they have been inventing lighter and better papers, with no sacrifice in opacity, and they cost a lot less than the old-fashioned papers.

Just think what good could be done with the nearly $200,000 a year that might be saved in the publishing of QST! A small fraction of that would keep a man on the road visiting foreign governments on the behalf of amateur radio on a year round basis. Another fraction would buy us publicity and promotion for amateur radio in the top mass-circulation magazines. Ask your director about this and listen very carefully to the explanation.

Again, please let me emphasize that the above is written in the spirit of constructiveness, recognizing that no organization, not even the ARRL, is absolutely perfect and above improvement. You should recognize that it is unlikely that

(cont. on page 81)



Repeater Update

At a recent FM forum, Bob Peterson K2IEZ asked me why I never included in the periodic repeater directory systems that required the use of continuous subaudible tones. I emphatically told him – and the others present – that I would not list such repeaters because they could not realistically be considered as open repeaters. Continuous tone – unlike tone-burst entry – involves some rather precision tone generation equipment. Levels for continuous tone (PL) are unusually critical, and even an error of 0.5 Hz will keep the user from being repeated.

Well, since the forum I've had a change of heart. FM isn't quite the new thing that it was a few years ago. More and more repeaters are going up, and they're going up more and more frequently with overlapping coverage areas. In many cases, use of PL is the only practical means for avoiding interference with adjacent repeaters.

So, while I would still like to discourage the use of PL (because PL itself discourages newcomers from getting a taste of the fun of repeater operation), I will include PL repeaters in the directory, regardless of frequency of operation. The only requirement for directory listing is that the PL frequencies must be included along with the operating frequencies.

If you operate a repeater that welcomes transients, write the particulars on a sheet of paper or a postcard and send it to 73 right away. We are currently preparing a repeater directory "update," and want to make it as accurate as possible. We want to list all open repeaters, on 6 meters, 2 meters, or 450 MHz. But hurry – we don't have a lot of time.

The Busiest Check Around

When I returned from the Orlando hamfest, 73 gave me a $10 check as reimbursement for some out-of-pocket expenses I'd incurred in Florida. But rather than cash the check, I kept it in my wallet for a few days.

Then, when Betty Daniel WB6AOF, a friend of mine from California, spent nearly $10 to mail me an airmail package from my home town, I just endorsed the 73 check and mailed it to her.

Betty's husband, Fred Daniel W6NQS, owed Don Milbury W6YAN $10 for a crystal purchase Don had made. So, since it was Fred's money that had paid for the mailing of my package anyway, he asked his wife to sign the check over to Don–which she did.

But Don was interested in getting a subscription to 73 Magazine, so he endorsed the check and sent it back to its home in Peterborough.

The story doesn't end here, though. That crystal that Fred bought from Don was really from Wayne Green's Handie-Talkie. Fred is owner of Communications Specialties, the company that put Wayne's Handie-Talkie on frequency. Since Fred had paid for the crystal, he sent Wayne a bill from Communications Specialties for $10. Guess what check was used to pay that invoice.

A Free Plug (It's a Pun)

If you've recently purchased a Galaxy FM-210 2 meter FM transceiver, you've no doubt learned that it comes less microphone. The unit has a PL-68 receptacle built into the front panel and is designed for a high-impedance ceramic or dynamic mike. When Wayne and I bought our FM-210's, Wayne had the foresight to order a couple of push-to-talk mikes from Meshna Surplus (Box 62, E. Lynn, Mass. 01904).

These mikes warrant mention because they sell for only $5. They are attractive, hand-held jobs with built in push-to-talk switch and an ample length of three-conductor curly-cord. I rate it as a great buy. The fellows from Meshna say they'll throw in a PL-68 plug, too, if the buyer states the mike is for an FM-210 (while Meshna's PL-68 supply lasts, that is).

Another commodity we picked up from Meshna that should be of particular interest to FM'ers (because of the FM'ers lust for frequency stability) is tunable NPO capacitors. Meshna sells these individually (3–12 pF) for 25 cents, or in "banks" of 24 for $3. The 24-bank array includes five 3–12 pF, fourteen 5–25 pF, and five 8–50 pF. I bought a batch of these to replace some rather questionable "original equipment" variables.. (The banks, by the way, are difficult to separate into individual capacitors).

Repeater Users!

Last chance to correct 73's listings for your area. A new *repeater update* is being prepared for publication in an upcoming issue. If your repeater has not yet been listed, mail complete info to Repeater Directory, 73 Magazine, Peterborough N.H. 03458. Include repeater call, area served, tones required (if any), essential data (narrow or wide, times of operation, etc.), input and output frequencies. Do it now!

73 Repeater Slide Presentation

73 would like to make up a tape-and-slide presentation for use by radio clubs across the country. If you'd like your repeater featured, send us a few representative 35 mm slides with explanatory or descriptive information. We'll combine yours into the "carousel" and work your information into the story.

. . . K6MVH ■

AN
EDITORIAL
by
DAVE MANN K2AGZ

Leaky Lines

1 DANIEL LANE, KINNELON NJ 07405

By unofficial count, and with some willfully inaccurate exaggeration thrown in for good measure, I estimate that there have been approximately 673,492 references in the press respecting pollution of the environment. Of this, about half has dealt with air pollution, slightly less with water impurification, and the remainder with adulteration of food, indiscriminate spraying for insect pests, noise, and other miscellaneous types of environmental deterioration. The least mentioned item in the list has been noise pollution, meaning the clatter of garbage trucks, automobile horns, compressed air drills, blasting, fire sirens, sonic boom, city buses, cats serenading from back-alley fences, and Puertoricquenos playing bongo drums and guitars on the sidestreet stoops of the city after midnight.

In very few instances can I recall any mention of a specific form of atmospheric despoliation with which we radio amateurs are vitally concerned; namely the pollution of the airwaves in the form of unwanted hash on the station receiver. Apart from ordinary, everyday QRM and QRN, we are forced to contend with a veritable smorgasbord of obstreperous sounds, any one of which is guaranteed to drive you stark, staring mad in a trice, or a couple of trices. There's ITV, from those verdammte 15,000 Hz horizontal TV oscillators; IDD, from misbehaving diathermy devices; INS, from malfunctioning neon signs in bars and grilles; IVW, from the hot ignitions of Volkswagens and other foreign compact cars; IBI, from broken insulators on power poles; IEB, from electric blankets; IRT, from refrigerator thermostats; ICO, from can openers; ISM, from sewing machines; and even IRCBPBASORASLH, interference from rectification caused by poorly bonded aluminum siding on ranch and split level houses! We have no shortage of supply; noise in this society is as ubiquitous as was horse manure to an earlier age, before the proliferation of mechanized modes of conveyance. But, at least the manure nourished entire generations of English sparrows. Of noise, very little good can be said!

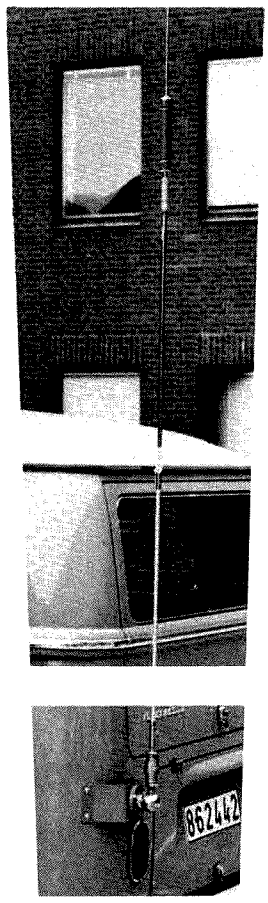
Everybody is jumping on the antipollution bandwagon! President Nixon in his state-of-the-union speech last winter said that his Administration is determined to come to grips with the problem of our air and water. The late Rachel Carson, in her books *Silent Spring*, and *The Sea Around Us*, dealt in great detail and depth with pollution's awesome effects upon our ecology. And the redoubtable Ralph Nader has been wielding his cudgel against the unscrupulous culprits who have been sullying out food supply with harmful chemical additives. The conservationists campaign against our traditionally lackadaisical apathy, and it is difficult nowadays to find a single newspaper or magazine in which the subject is not discussed. But hardly a soul, except some lone, isolated acoustical engineer, writing a monograph for a ceiling tile manufacturer, has seen fit to spell out the dimensions of the noise menace in all its truly perilous proportions. In addition to all the other types of noise pollution, something must be done about the lousing up of the radio waves.

By this time we all recognize the power of small but vocal minorities. Once the public becomes aroused and angry... once the sleeping giant awakens... there's very little he cannot accomplish. Indignant nature lovers, in a tizzy over plans to build an atomic power plant on the majestic Hudson at Storm King Mountain, raised incredible furor. Even disreputable looking, bearded, guitar-playing folk singers joined the crusade. Despite a company sponsored survey which showed that only very minute thermal changes would occur, and guaranteed only minimal deleterious effects upon the fishes of the river, the antagonists have so far successfully withstood all efforts to establish this installation, and it remains an unfulfilled dream to this very day...a monument to the irresistible power of public indignation. The righteously wrathful spirit of Carrie Nation rides abroad throughout the land. And woe betide any would-be opportunist who stands in its path!

When TVI occurs and customers complain, manufacturers of TV sets supply free components to clear up the problem. Why are they permitted to omit the highpass filters at the factory? Because it's an economic factor, of course. But, isn't it ridiculous to have to deal with each and every situation on an individual basis? Well, just suppose the problem never materializes on a high proportion of the sets? For each of these trouble-free sets the manufacturer saves the cost of such preventive components, resulting in a not inconsiderable aggregate total.

(cont. on page 63)

mount that mobile right!



The right kind of mobile installation will result in bigger signals, better operator safety, and more fun in hamming on the road.

Joe Carr K4IPV
511 New York Avenue
Norfolk VA 23508

After several years in the automobile radio field and almost ten years in amateur radio, the author supposed that he had seen just about every atrocity that can possibly be committed in the mobile mounting of a piece of auxiliary electronics equipment. This assumption is constantly proved wrong by new installations that range from the tragic to the immensely funny! The truth is that a little forethought and some basic craftsmanship will prevent most of the headaches usually cited as objections to mobile operation.

Placement of Unit

For this discussion we will define "main unit" as a transceiver, receiver/transmitter combination (such as was popular a few years ago), or other unit. Specifically excluded for the time being are the various remote control schemes commonly associated with trunk-mounted FM equipment.

Placement, in some cases, is often the most discouraging pitfall encountered during a mobile installation. Automobile manufacturers have displayed a positive genius for frustrating the plans of all but the most ardent mobile operators. They have designed auto interiors in such a way as to eliminate any possibility of mounting a mobile rig anywhere but in the trunk! Some of the problems encountered in trying to solve this particular pitfall include dashboards with inadequate strength or insufficient mounting space, transmission "tunnels" of odd shape or size, and general lack of room between the accesory panels and the floor.

The main considerations for determining placement are safety and convenience. The rather obvious assumption that excessive reaching while driving can be fatal sets a requirement that the unit be placed within nonstraining reach of the operator (unless, of course, no in-motion operation is contemplated). It is also a good idea to make sure that lacerated

knees and torn stockings don't result from the installation. In a one-car family, such can be the spark that ignites a disruption of domestic tranquility!

If a dashboard mount is impossible, the transmission tunnel may be adequate. A surprising number of installers overlook this possibility by not knowing that most of the mounting brackets supplied with modern transceivers can be attached from either the top or the bottom. Even if this is not the best method of mounting, a little imagination and a few odds and ends will improve the situation.

Dash Mounted Units

The most usual mounting method is the familiar "U" or channel bracket suspended from the underside of the dashboard. This bracket is fastened with screws to both the dashboard and the mobile unit (Fig. 1). A mistake that is often made is the use of too lightweight a screw. The best are machine screws fastened with a star washer and two nuts. It is, however, not always possible to use this method. If, for instance, the upper side of the dashboard lip is inaccessible, then self-tapping screws are in order. Whichever fastener is decided upon must be substantial enough to hold the unit securely. Lightweight units can be held with a No. 10 screw; heavy units with a No. 12. If a larger screw is required for any particular unit, then there are serious doubts as to the dashboard's ability to support the unit.

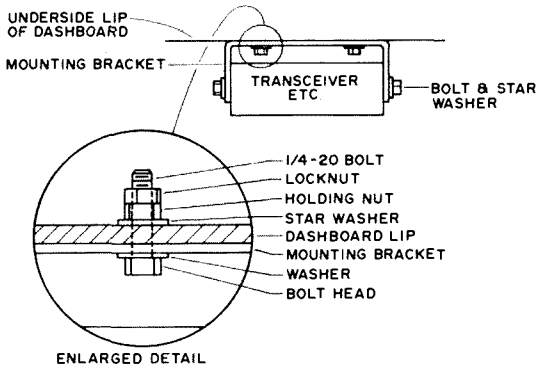


Fig. 1. With lightweight, low-power mobile transceivers, a simple mounting bracket can suspend the unit. The rear of the transceiver can be held with a bracket fixed to the firewall.

Floor Mounting

If, for any reason, the rig cannot be suspended from the dashboard, a good alternative is the transmission tunnel. As mentioned before, most brackets can be upended and installed from the bottom.

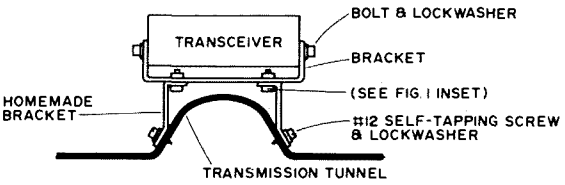
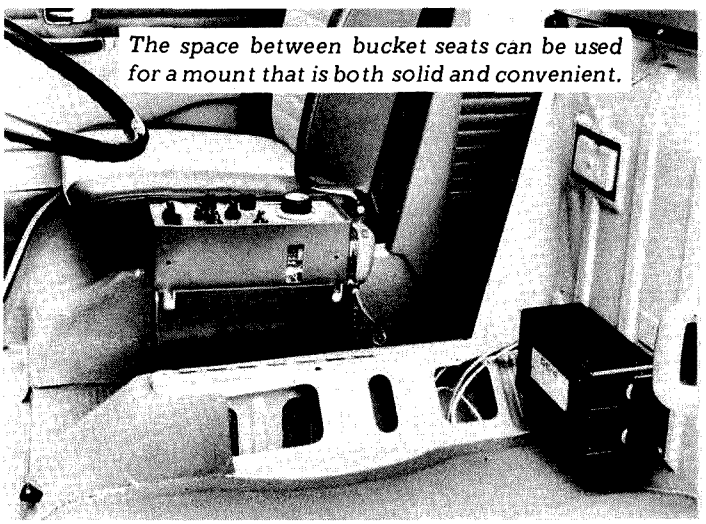


Fig. 2. Since most transmission humps differ in size and configuration, mounting here usually requires a bracket of special design. A little metal work, though, will result in a very effective and solid installation.

Figure 2 illustrates one possibility. The rig may be mounted either horizontally or vertically (perhaps resting against the seat). Again, screws that will bear the load are essential. (If your car has carpets instead of rubber floor mats, DO NOT USE A DRILL to make holes for the screws. The carpet thread will wind up around the drill bit creating a very amusing pattern in your once conservative rug.)



The space between bucket seats can be used for a mount that is both solid and convenient.

In some bucket-seat vehicles such as the van shown in the photos, an ideal installation is the area between the driver's and passenger's seat. Many transceiver manufacturers also produce brackets that result in a sturdy installation yet which permit quick removal of the unit.

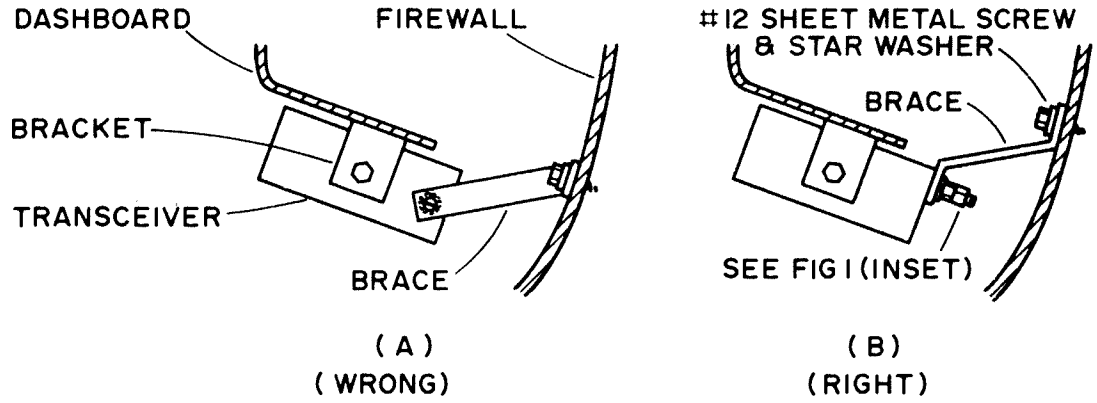


Fig. 3. The bracket at the rear of the unit should be placed near the center of the transceiver's back plate, as shown here. If a single bracket is mounted at the side, an undue strain is placed on the front bracket and the unit can vibrate loose in a short time.

Bracing

Vfo stability, the continued good health of the rig, and some safety considerations depend in large measure on the stability of the installation. It is surprising that some operators will sacrifice the good repair of their unit (vibration plays hob with electronics gear) for the relative ease of a braceless installation. A piece of stiff metal pipe strap, a length of angle stock, or any substantial material can be used, depending on the particular situation. It may, in some cases, be necessary to drill a hole in the rig to provide for such a mount. Some reputable manufacturers overlook this necessity because mobile operations are a second thought. A ¼-20 screw is preferred for this use. Figure 3 shows right and wrong ways to make a brace.

Speakers

With the advent of automotive stereo tape players, there have been a large number of speaker mounting systems introduced that are possibly better than the traditional mobile speaker. These usually can be mounted behind the dash completely hidden from view. Care should be exercised in selection of these units not to obtain one of the door mounting units. Most cars use the door interiors as a rain drain, making it a rather unhealthy place for loudspeakers. Check out auto radio and other stores that deal in tape players. They should have a stock of such mounts. You should remember that your best bet is to have the speaker pointed toward your ears. The audio you'll be listening to is not hi-fi, and you'll need as much intelligibility as you can get.

Antennas

A discussion of antenna techniques deserves a treatment of its own. Such a treatment is given in both the *Radio Amateur Handbook* and the *Mobile Manual*. The only comments appropriate here are a matter of opinion. There should be a definite trend away from bumper mounted antennas. They are a lot less substantial and a whole lot more aggravating than other types. As for the objection to cutting a hole in the body of a car, it is of little importance in most cases. Holes can sometimes be filled at low cost.

Power Considerations

Except for taking care to mount power supplies where good ventilation is provided and passengers' feet avoided, there is not much to mounting power supplies that



With the seat in place (covering the Drake's power supply), the power cables and antenna lead-in are out of sight. The microphone drops out of the way, too, and clips onto the side of the rig. (Probably the most important single consideration with any mobile setup is microphone cable routing. Lack of care in underdash rigs can lead to steering wheel entanglements and other such embarrassments.)

cannot be inferred from the above paragraphs and photos.

Another case entirely is the power supply hookup. Rigs in the CB power class can be hooked up through the auto ignition switch, even though it is *not* recommended. This is accomplished by locating the accessory terminal of either the switch or the fuse block.

A higher power rig (as most are these days) must be hooked directly to the battery with wire heavy enough to carry the current load without heating up or causing an intolerable voltage drop. Remember, a rig that requires 200W of line power will draw almost 17A at 12V. The nature and cost of high-amperage switches makes relay control look better from many standpoints. In general, it is *not* a good idea to connect the power lead to the fuse block. Run it straight to the battery of the battery terminal on the engine starting solenoid.

One often overlooked problem regarding the power hookup concerns the possibility of picking up motor noise transients. All wires that are run through the engine compartment have the potential of picking up noise. Under all circumstances these leads should be dressed away from the ignition coil and its associated wiring. Shielding is also desirable. The shielding braid on the larger sizes of coaxial cable may be of sufficient diameter to handle the current drawn by a low- to medium-power rig.

The long multiconductor harnesses usually associated with trunk-mounted



The biggest problem of vertically mounted rigs is that the operating panels tend to collect dirt. A dust cover will keep dirt out effectively and will reduce the chances of someone spilling coffee or cola onto your new Drake. The inexpensive cover also discourages tampering and accidental knob-bumping.



The antenna warrants a great deal of thought. It should be mounted as far from the road as possible to minimize noise pickup; it should extend as high above the vehicle as practicable. Both these objectives are achieved in this Volkswagen installation, where a special plate is installed for mounting the Hustler antenna away from the vehicle body. This type of installation requires some weatherproofing where the coax feeds the spring base.

installations should never be run down the same side of the car as the normal automotive wiring. The proximity is likely to cause noise pickup by mutual coupling. A more complete treatment of noise problems can be found by consulting the *Handbook, Mobile Manual*, and the author's article in *QST* (July, 1968).

Preparation

One of the prerequisites for any major project is preparation. For a mobile radio installation a good selection of tools is essential. An electric drill with a collection of bits suitable for the uses that will be encountered, a collection of wrenches and other hand tools, and a reasonably good place to work will make the job a whole lot easier. A comprehensive study of the *ARRL Mobile Manual* and appropriate sections of the *Handbook* are both likely to help the mobile aspirant to avoid some of the mistakes that are made all too often. These publications also contain information that will aid in making some of the decisions and choices that inevitably pop up from the very beginning of such projects. . . . K4IPV ■

Bill Hoisington K1CLL
Far Over Farm
Peterborough NH 03458

Amateur Wattmeter for $3.85

. . . tells you your power output from 10 mW to 5 watts, over the range from 160 meters up through 450 MHz

This article describes a very useful gadget for determining the rf power output of solid-state VHF–UHF transmitters in the difficult range to measure, from about 10 mW up to 5 watts. It does not read watts directly; but by a simple comparison of calibrated pilot light brilliance, it will tell you how many watts you are putting out, to within less than 5%. It allows you to check power increases and estimate your efficiency quite close.

Principle Involved

We'll start right in with this part because, while this unit is not by any means a "trick," it does not read rf directly. You first light a pilot light as a good dummy load, matching it into the rf tank circuit of your transmitter by the normal means, also noted here.

You then switch on a second bulb of the same type by means of a battery, controlling the light output with a $1.30 wirewound potentiometer in series, as shown in Fig. 1. This pot must be previously calibrated in milliwatts, as by the method of "volts times milliamperes equals milliwatts." You then match the brilliance of the bulb lit up with rf or its dull glow at some 18 to 25 milliwatts if you're just getting your transmitter going, and read the watts on the wattmeter dial. It's astonishing how well it works, how repeatable it is, and how you wouldn't be without it once you build and calibrate it.

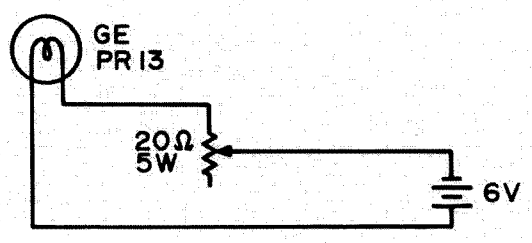


Fig. 1. The circuit supplies the brilliance "standard" for comparison. When the "standard" lamp is mounted adjacent to the dummy load, the pot permits variation of the standard to match the load. If the resistance is panel-marked in watts, a good power indication is achieved.

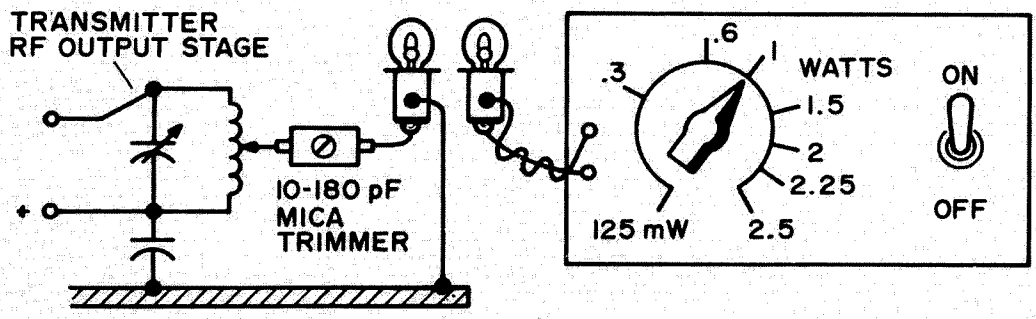


Fig. 2. A series capacitance loads the rf indicator for comparison. The capacitance value will decrease inversely with frequency increases.

Brilliance Standard

Figure 2 tells almost the whole story at a glance. You can, of course, put as much calibration on the dial as you have time for. It is quite important to orient the bulb filaments in the same relation to your eyes for best matching. There isn't much in back of the panel except one 6V battery which can be obtained in any hardware store.

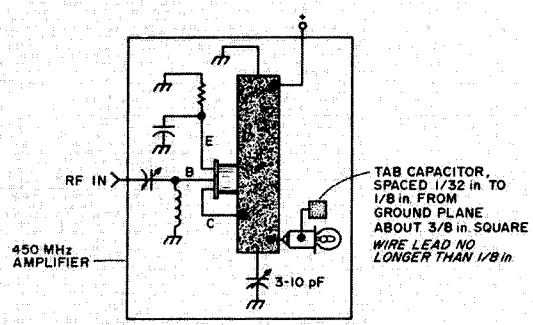


Fig. 3. Matched pilot light load for the UHF version.

RF Matching

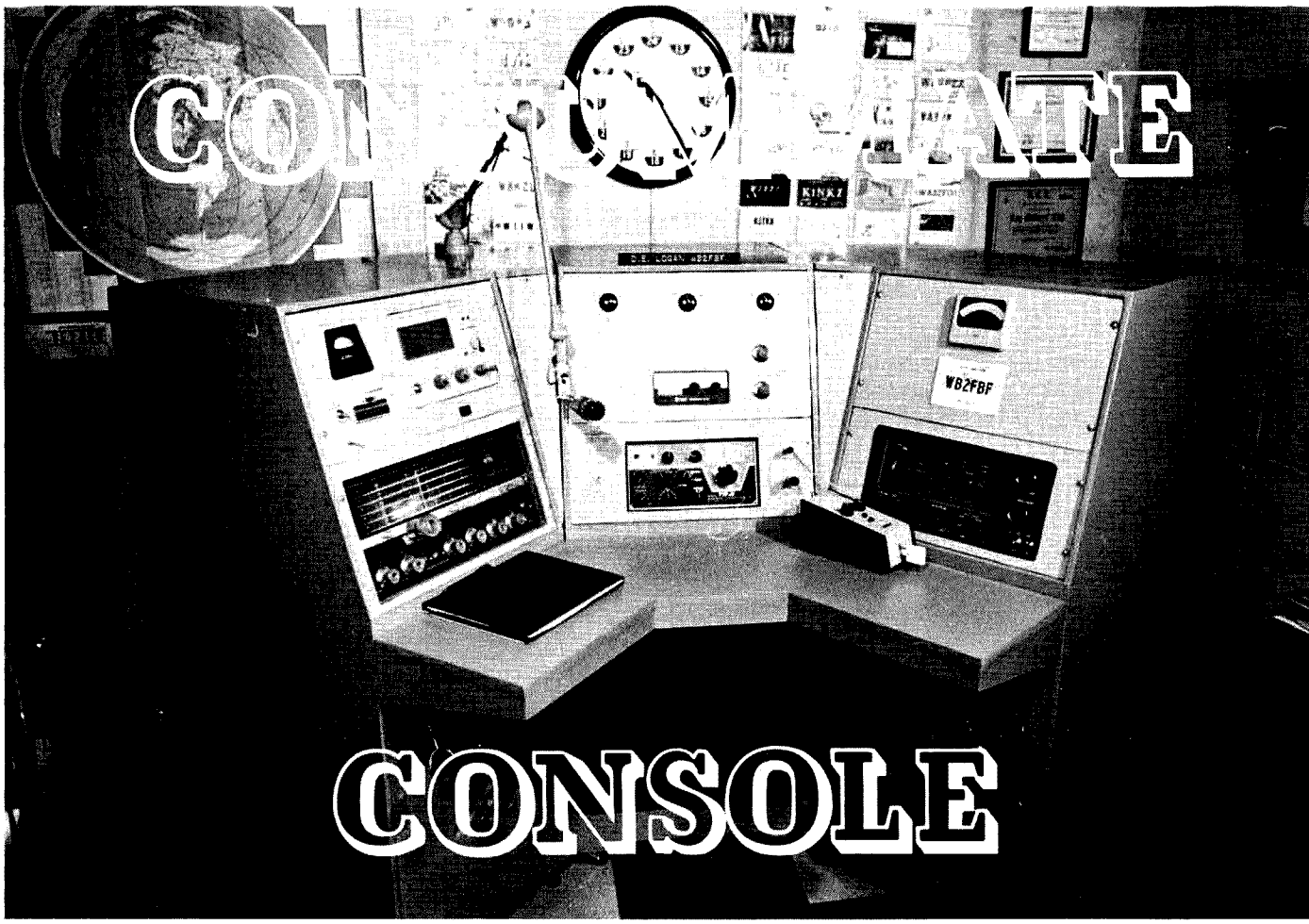
Not that it is particularly critical, but be sure and note the need for a large range of series capacitors for the rf pilot lights as you go up in frequency. This can be seen clearly in Figs. 2 and 3. The block diagram, Fig. 2, shows a 6 meter setup. As you go up in frequency the series capacitance drops. A good matched load on 432 MHz can be obtained as shown in Fig. 3. I sometimes remove the tin base from the bulbs, but this is not an absolute necessity. It is important to vary the amount of coupling, and thus the series capacity, by spacing the tab capacitor closer or further away from the ground plane, as detailed in Fig. 3. You also can use as many bulbs as you can solder onto a tuned rf inductor, even though they don't all light up with the same brilliance. You can match them all up, but you don't have to. Just check the wattage, or milliwattage, of each one and add them up for the total.

The number 48 or 49 bulb, listed at 2V and 60 mA, is rated at 120 mW, and glows dim at about 12 to 15 mW; so it can be used for low-power receiver oscillators, etc. With two other bulbs found in hardware stores, connected and matched to the rf inductor, such as the PR13 (5V at 500 mA), you can read correctly up to 5W. From there on up you're on your own, although a good variable 115V dc supply can be made up to work around 50 to 100W. I generally use a variety of 115V bulbs of different wattage, light them up with rf, and use their rated wattage.

. . . K1CLL ■

THE CONSOLE

Dee Logan WB2FBF
21 Judith Street
Nanuet NY 10954



Increasing station efficiency and enjoyment with a broadcast-style console.

Most hams go to great lengths to achieve peak operating efficiency from their station equipment, but seem to spend far less thought on station layouts that could also add to their operating efficiency and enjoyment. If you've been growing irritated with the teetering stacks of equipment and tangled snarls of cable that have resulted from random station growth, you may be ready to get organized via a station console.

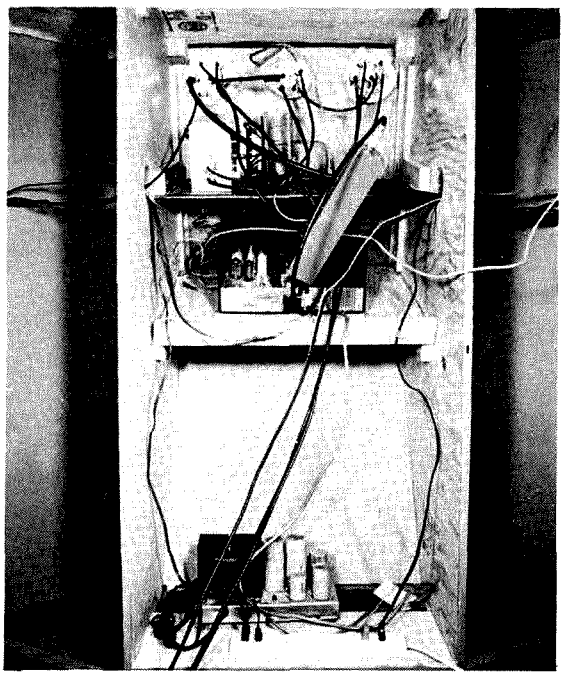
I formerly worked in commercial broadcasting as a combination engineer–announcer and realized from first-hand experience that it's possible to run an entire radio station from one operating position. The key is in the console that allows one man to control mikes, turntables, tape recorders and transmitter without leaving his chair. That's efficiency! Wouldn't that same approach be welcome in the hamshack?

Since most amateur radio stations have but one operator, the evolution of the console design can revolve around meeting his specific needs. It will, for example, mirror his operating habits, modes of operation, and personal tastes. The design for a serious DX'er will undoubtedly incorporate features that wouldn't be as important to the more relaxed, feet-on-the-desk ragchewer.

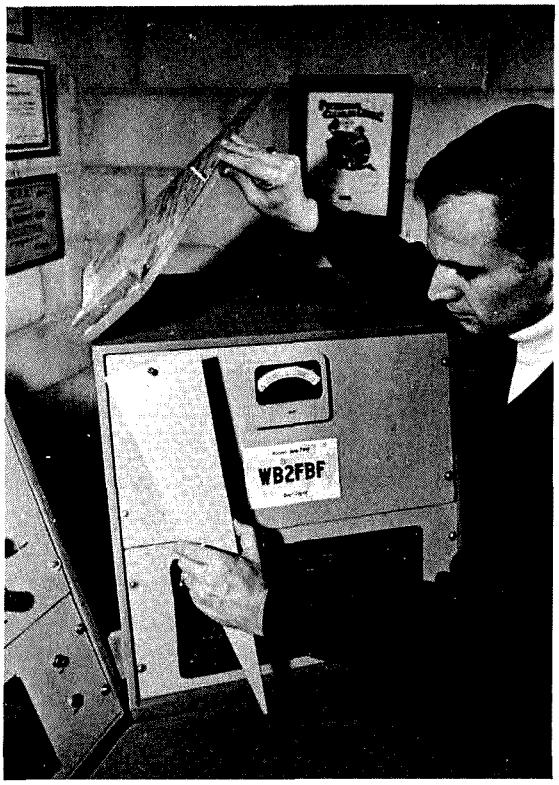
It might be pointed out that any design should result in a dramatic transition of your station from a random collection of individual components into a smoothly functioning system.

Once priorities are established, the evolution of a console system should follow some "noodling" with pencil and paper. Use a little "human engineering." This is loosely defined as calculating the optimum position, size, and motion of switches, knobs, and controls to achieve the most efficient operation with minimum fatigue (or frustration!). This may extend to such subtle points as the color scheme (light colors in greens, blues, and grays are more restful backgrounds).

The station console at WB2FBF evolved after researching what others had done, including K2YIH, who described a similar console in 73 back in November of 1963. Admittedly, a tour of NASA's Manned Spacecraft Center in Houston did a lot to start my dreams about what the station *could* become with the proverbial elbow grease, in lieu of an astronautical budget!



Behind the console panels, neatness doesn't matter quite so much. Large holes in the plywood cabinet sides facilitate cable routing; coaxial switches help to keep transmission lines out of sight.



When the console bays are placed together, there will be large space gaps unless you build special-shaped wood sections like these. They add a professional touch and lend a look of uniformity to the three cabinets.

Basic Design

The U shape of the console is actually formed by three wheeled sections that are held together by a bolted-on operating tabletop, hinged braces in the back, and five-sided top pieces that fill the spaces between the center section and each end. A pair of triangular pieces of Masonite are used in front.

The entire console, when broken apart, is narrow enough to roll through our basement door. Also, the wheels allow the operator to roll the complete unit away from the wall for easy access to the rear. Equipment is arranged in custom-cut panels that slope away from the operator about 6 in. at the top.

The arrangement utilizes the center section for the main operating area, and consequently includes the transceiver, swr bridge, antenna coupler, and an antenna network of coaxial switches. It's possible to quickly switch from dummy load to any of several antennas or to switch in a scope or antenna tuner as needed. The left panel contains the VHF area: Twoer, converter,

rotor control, and SX-111 receiver. On the right is an all-band receiver, ac line monitor and scope (added since the photograph was taken).

Lower portions of the end sections are used for storage of power supplies. Hinged front panels are used as baffles for speakers. The lower part of the center section is left partially open to supply legroom by running a Masonite piece diagonally down to the rear.

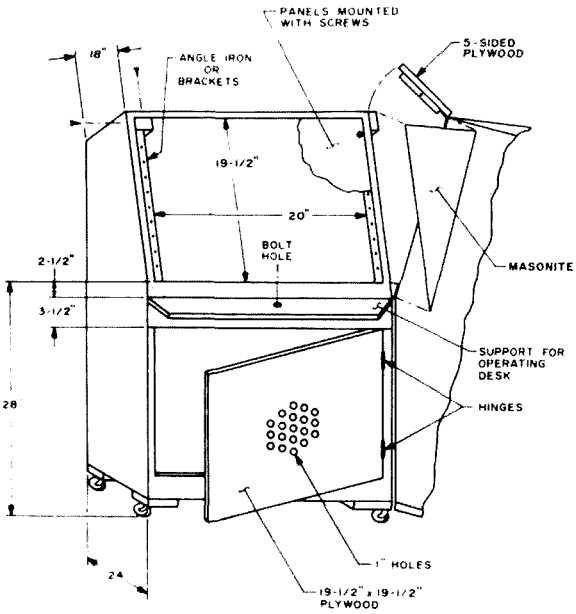


Fig. 1. Sketch shows general construction data for each console bay. Three of these bays form the operating console.

The console sections (Fig. 1) are each 20 in. wide (inner measure). This is an arbitrary dimension and is based upon accommodating the widest piece of equipment: our SX-111 receiver. The console is 48 in. high measured from the floor, with about 3 in. used for the hard rubber wheels that are mounted on pine squares on each corner. The operating desk provides a 12 in. deep writing surface, and is positioned 30 in. above the floor. Each console section is 24 in. deep, but is 6 in. less at the top due to the diagonal slope required for the panels.

Construction

Plywood, pine, and Masonite are the prime materials used in the construction. Interior-grade 0.5 in. plywood is used to form the three main sections. Two wafers of plywood form the sides; pine pieces are used at the bottom and front, held to the plywood by countersunk screws and glue. Use wood filler to cover the screws and sand smooth.

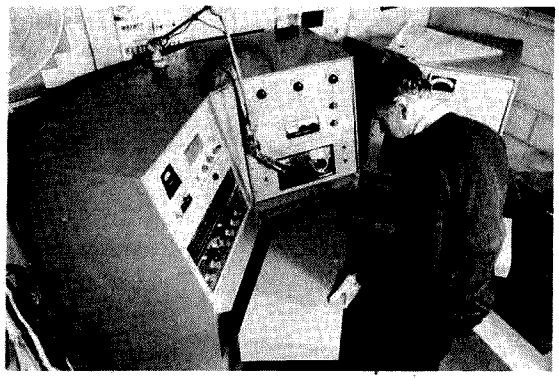
The top of each section is made of a plywood square, with reinforcement under each corner supplied by blocks cut from 2-by-4's. Use plenty of glue, wood screws, and cover the screw heads with filler. A bottom shelf is likewise made from plywood or Masonite.

One detail worth noting is the support for the operating desk. This is formed by making a narrow ledge about 3 or 4 in. deep out of plywood and sandwiching it between the pine pieces across the front of each section. The ledge should be about 27 in. up from the bottom so that when the wheels are added, the total height will be 30 in. above the floor. Be careful not to run this ledge the full width of the section; and cut the ends diagonally since it will be turned on an angle when joined with the other sections. The operating desk is added later and rests on the three ledges, attached by three countersunk stove bolts (one for each section of the console) and wing nuts.

Before mounting the speaker baffle panels on the bottom of the two end sections, drill a series of 1 in. holes in a pattern appropriate for the speaker sizes. Be careful not to splinter the plywood when drilling, and remember to cut into the finished side slowly. I used a circular saw and experiment on a piece of scrap beforehand.

After completion of the three sections, the general shape of the console can be arranged by pulling the individual sections together. The angle decided upon for our console was about 120 degrees between the center section and each end. Locking the center section to each end is done via hinged slats at the bottom rear, and a "trailer hitch" type of overlapping block near the front. Once the three sections are locked in place, measurements can be made for the five-sided plywood pieces that fill in the top and the pair of Masonite triangles for the front.

One thing confronting me in respect to finishing the plywood edges was in locating 0.5 in. wood strips at our local lumber yard. Since I lacked adequate power tools to cut the strips at home, some filler was called for. Cellulose-type filler goes on easily, but is difficult to sand down, so I opted for water putty. This is a powder



The desktop mounts neatly right over the support joists, locking the cabinets into a single three-bay console.

compound that can be mixed with water to produce a paste that can be applied to the plywood edges with a putty knife. When dry, it sands down easily.

Equipment Panels

Mounting equipment in a console of this type suggests at first glance that everything is virtually locked in for the future, but such isn't the case. Unless a console is flexible enough to allow for changes, it will eventually grow obsolete.

I selected easily cut 0.25 in. plywood and Masonite as the material for the panels, though aluminum sheet would provide a suitable surface if direct mounting of equipment on a panel is chosen. A series of shelves is arranged behind the panels and the equipment rests on these with the front protruding through openings cut to size in each panel. I made paper templates of the equipment and scored the panels with a pencil before cutting.

To mount the equipment panels in the console, angle iron with tapped holes would be ideal. Lacking that, I used wood strips surfaced with scrap chrome. This allows the panels to be mounted with either metal or wood screws.

Operating Desk

Since the operating desk (Fig. 2) must fit snugly against the main console, it shouldn't be started until the console itself is completed. To insure a good fit, make a template from cardboard or stiff paper before putting saw to wood. Plywood forms the surface of the desk and angled end supports, but I used pine for edging.

Once the desk is finished and in position, drill three holes – one on each edge near the console – through the desk and down through the supporting ledge. Add stove bolts, countersink, fill, and sand smooth.

One feature of the console that adds the "commercial look," is the Textolite plastic laminate used on the desk surface. The color was selected to match that of the main console, and provides color "coordination." Alternate materials would suffice, such as cutting up an old dinette table's Formica top. There's also the old standby of linoleum or asphalt tile.

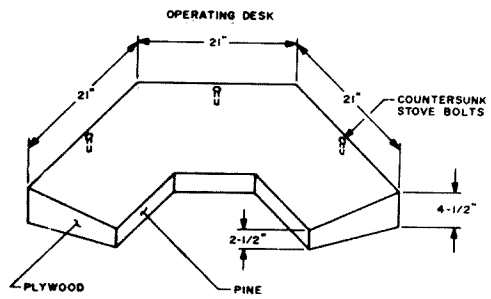


Fig. 2. The tabletop is inclined slightly for operator convenience. The design shown here was used in the author's console, but individual preferences may dictate slight differences in layout, slant, etc.

Finishing Touches

Since plywood is a thirsty material and rather grainy, take time to sand the entire unit well and then apply a good primer. Use good-quality high-gloss enamel for the finish and apply several coats. Allow for a

bit of extra paint to keep on hand for touchup later.

Panels holding the equipment are painted battleship gray, which is a standard medium color that "wears well." This contrasts with the light bluegreen used on the main console and operating desk. Gray blends with most pieces of commercial gear.

Labeling was done with "burnish-on" instant lettering dry transfers. A Datakoat protective coating will keep the letters permanently in place. The use of rub-on lettering does add quite a professional touch to the final product.

Electrical

The possibilities of designing various wiring networks for antennas, ac, audio, and accessories are virtually endless, and depend upon the station equipment to a great degree. I devoted my attention to the rf switching network—including the antenna switching system. A very complete discussion of the electrical aspects of console design was in 73 January 1969, and since W6GDP detailed it well, there is little need to cover it again.

One point might be covered, however: the use of commercial coaxial antenna switches provides efficiency and convenience over the alternate method of manual switchboard-type patching. It's one of the main selling points of any console to be able to eliminate the old juggling act of manually changing antenna coax when switching bands. My antenna network includes three coaxial switches (grounded, by the way) that allow selection of several antennas or dummy load, switching in or out the antenna coupler or monitor scope, and directing the antenna to several possible transmitters or receivers.

Piece de Resistance

A flexible microphone boom was added to the console (a "Flexo Mikester") and thus clears the operating desk of one more piece of gear. Audio cable is run to the transceiver through the rear, and since the TR3 has side-mounted jacks for phones and key, these were disabled and bypassed to standard jacks mounted on the console panel. A push-to-talk switch is likewise mounted outboard of the transceiver.

After a shakedown period, the cables and associated wiring inside the console should be secured with cable clamps. Cable runs between console sections are via holes cut in the middle of the interior walls. A hefty ground bus should be installed in each section.

One last note about keeping the desk clear of accessories: remember that there's plenty of room to mount small black boxes under the desk or in the storage area behind the speaker baffles. I had a surplus audio filter that was a "must use" with the transceiver and found that it could be neatly tucked away under the operating desk with four screws. I keep headphones out of the way when not in use by hanging them under the desk on a couple of hooks.



Removal of the tabletop and triangular "gap fillers" permits easy disassembly of the station for removal and transport. Note the "trailer hitch" connection between sections at lower right.

A good coat of paste wax on the finished unit will wrap up the job. Then you can sit down and enjoy a new dimension to hamming with everything under control and at your fingertips!

. . .WB2FBF ■

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AN IMPEDANCE MULTIPLIER FOR THE VOM

A voltohmmeter or similar device can be found in almost every shack. The typical VOM is inexpensive, rugged, and independent of the ac mains. However, it has a disadvantage in that it can't be used to measure voltages in relatively high-impedance circuits without some loss in accuracy. Consider the circuit in Fig. 1. A VOM is being used to measure the voltage drop across R2. A typical VOM has an input impedance of 20 kΩ/V (or less). This means that the input impedance of the VOM, in ohms, is 20,000 times the full-scale voltage.

On the 10V scale, for example, the input impedance is 200 kΩ. If R1 and R2 are relatively small, say 2 kΩ, then the effect of shunting R2 with the VOM will be small. In Fig. 1, if the applied voltage is 20V, then the VOM will read approximately 9.9V. On the other hand, if R1 and R2 are 2 MΩ, then the VOM will read approximately 2V! Clearly, one solution to the problem is to buy a VTVM with an input impedance of 22 MΩ or so. A less expensive solution is to build the impedance multiplier described in this article.

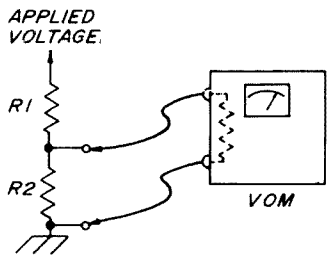


Fig. 1. Circuit under test by VOM.

The schematic of the unit, shown in Fig. 2, consists of a voltage divider which presents a 25 MΩ impedance to the voltage being measured, and an operational-amplifier unity-gain voltage follower.

The voltage follower has characteristics which make it ideal for the task at hand. Its input impedance is of the order of several hundred megohms so that it does not degrade the accuracy of the voltage divider. Its output impedance is less than an ohm and it can supply up to 5 mA (or more, depending on the amplifier used), so is virtually unaffected by the VOM. Finally, as its name implies, its output voltage is (for all practical purposes) the same as its input voltage.

For the ham who is looking at his first operational amplifier circuit, the following may be helpful.

An operational amplifier is a linear, high-gain, direct-coupled amplifier, usually provided with a differential input, but with its output referenced to ground. The usual symbol is shown in Fig. 3a. If a small voltage (a millivolt or more) is applied, the output voltage will swing to one or the other of its limits (typically ±10V). Only for voltages less than about 0.1 mV (for the ZEL-1) will the output voltage not be at one of its limits.

The polarity of the output voltage depends directly on the polarity of the

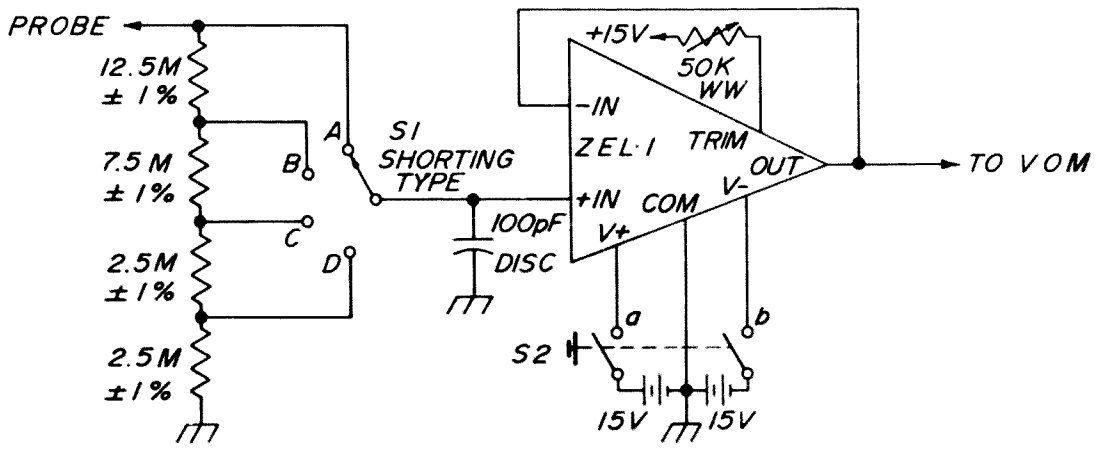


Fig. 2. Schematic diagram of the impedance multiplier.

input voltage. That is, with the positive lead of the source connected to the positive input of the amplifier, the output voltage will be positive, and vice versa. Further, instead of connecting one voltage source across both input terminals, a separate source can be connected to each input, with the second lead of each source connected to ground. In this case it is the difference of the two input voltages which appears across the amplifier input. The key to the operation of the follower is that one of these voltages is the one we wish to measure while the other is provided by the amplifier.

A simplified schematic of the voltage follower is shown in Fig. 3b. Consider what happens if, say, +5V is applied at E_{in}. If E_{out} happens to be at some value other than very nearly +5V when the input voltage is applied, then a large voltage appears across the amplifier input and the amplifier is driven hard toward one of its limits. But as the output swings past +5V, as it must because of the polarity relationships enumerated above, the polarity of the input signal is reversed, which means that E_{out} will then start to swing in the opposite direction. Because the gain of the amplifier is large and the response time short, the voltage difference across the input terminals is quickly driven to a very small value and the circuit obeys the relation:

$$E_{out} = E_{in}$$

The voltage follower is only one of a wide variety of operational amplifier circuits. The interested reader is referred to the publications listed in the bibliography.

The circuit of the voltage follower is well known and time proved. The author has constructed followers using various amplifiers in a variety of electrochemical instruments. For the ham who is starting from scratch, two amplifiers can be recommended. First is the ZEL-1, the type specified in Fig. 2, which is available for $11 from Zeltex, Inc., Concord, Calif. While the ZEL-1 is expensive, it does tend to be forgiving about having its output shorted to ground and the like. For the less cautious ham, the μA709 is available at $2 from Poly-Paks, Lynnfield, Mass. 01940. It is not nearly so forgiving. A circuit which accommodates the μA709 is shown in Fig. 4.

Other than the fixed-value components, the main difference in the circuit require-

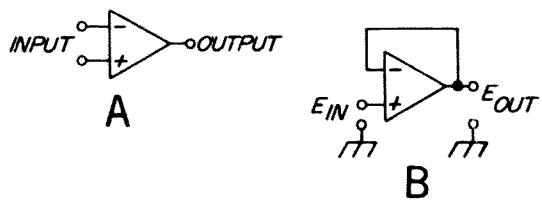


Fig. 3. The operational amplifier symbol and voltage follower circuit.

ments of the two amplifiers is the 50 kΩ trim pot which is used with the ZEL-1. The pot is used to adjust the follower output to exactly zero when the probe to the voltage divider is shorted to ground. In some applications, the absence of such a control

in the μA709 circuit would be a handicap. However, an error of only a millivolt or two is likely to result in this application. If a ZEL-1 amplifier is used, the pot may be replaced by a fixed resistor once the correct value has been experimentally determined.

to its 10V range, a full-scale range of 10, 20, 50, or 100V is provided when the range switch (S1) is in position A, B, C, or D, respectively. The unit may also be used with the VOM switched to a more sensitive range. As before, the voltage which appears at the output of the amplifier is the same

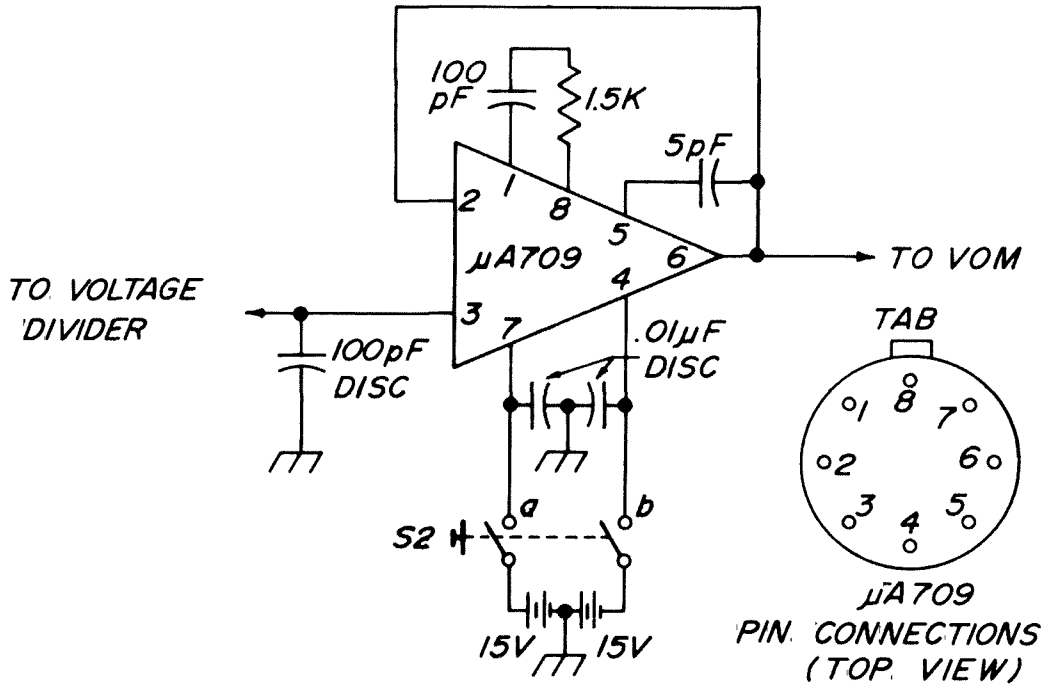


Fig. 4. Circuit modifications for μA709 amplifier.

The accuracy of readings made with the impedance multiplier in use will depend in part on the accuracy of the VOM involved and in part on the accuracy of the resistors used in the voltage divider. Since the garden-variety VOM has an accuracy of no better than ±2%, use of better than 1% tolerance resistors seems unwarranted.

A DPST switch should be provided as shown, in the interest of long battery life. Also, battery voltage should be checked frequently, since the output voltage swing capability of the amplifier depends markedly on supply voltage.

Physical layout is not at all important. The device will fit into a small minibox which can be provided with male plugs so that it can be plugged into the VOM in place of the probe leads.

Operation of the impedance multiplier is straightforward. With the VOM switched as that at the input of the amplifier, but the full-scale capability of the combination is reduced. For example, with the VOM switched to a 2V range and the voltage divider switched to position D, the voltage to be measured must be less than 20V or the VOM will go off scale.

The impedance multiplier may be used to make either dc or low frequency ac (audio) measurements. The only restriction is that not more than 10V may be applied to the input of the voltage follower.

Finally, I would like to thank Dr. Robert F. Nelson, in whose laboratory I first made the acquaintance of op-amps.

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REPEATER AUDIO:

TIME OUT FOR QUALITY

Use of a cathode follower to pick audio directly from the repeater's discriminator can do wonders for an ailing amateur relay system.

by Ken Sessions, Jr. K6MVH

Ask any FM'er to describe what he thinks is the most common problem in the world of repeaters. Chances are he'll say "desensitization." If he's a repeater owner, he'll probably tell you how he fought that isolation battle for days or weeks before he finally got the repeater transmitter and receiver percolating perfectly, 600 kHz apart, in the same building, using but one antenna, and with no noticeable receiver degradation.

But the fact that the problem was overcome, as it is in almost all heavily used repeaters, removes it from the "problem" category.

All right, then, if desensitization is not the most common repeater problem, what is? In my opinion, it's *audio* – rotten, garbagey, distorted, scrapey, overclipped, overlimited, asymmetrical re-pre-de-emphasized, lousy-sounding audio. And the reason bad audio is such a problem is that it just doesn't seem serious enough to warrant the extra engineering necessary to change it.

There's plenty of chances for repeater audio to go bad. First, there's the receiver: If the low i-f is out of adjustment, certain voice frequencies will distort and loud signals will squelch out of the receiver's audio passband. There's the chance for microphonic tubes, or improper de-emphasis circuitry.

Often, a repeater builder in a hurry to get a system going will connect the speaker leads of the receiver directly to the audio input of the transmitter. In doing so, he causes the receiver audio to be processed through so many circuits that degradation could take place even if by nothing more than the process of "diminishing returns."

Every stage loses something from input to output, and the slightest bit of distortion anywhere is immediately amplified and exaggerated in all subsequent stages. Consider the stages the audio must be cycled through faithfully: The repeater user speaks, and his microphone "transduces" the sonic waves into electrical signals. These signals are generated again in the output of the transmitter's af amplifier and phase modulator. The receiver processes the audio some more from the discriminator, through audio amplifiers, through the output transformer, and finally to the speaker, where the af is again "transduced" from electrical ac to air "pressure" waves. Considering what the audio must go through from one end of the system to the other, it is no wonder that some of our repeaters sound so bad.

All this doesn't come as any great surprise to most repeater owners. They know what's wrong and how to fix it. But sometimes they listen a little too subjectively to the product of their own handiwork. To them, it may just not sound bad enough to justify circuit modifications.

If you happen to know a repeater owner whose foot happens to fit the shoe of distortion, invite him to make the "comparison" test. At the repeater site, or near it, set up a two-channel receiver capable of monitoring the repeater input and output frequencies. This receiver must have the same bandpass limiting characteristics as the repeater receiver. Then, get someone to transmit a 1 kHz tone (at the receiver's maximum deviation-acceptance level) on the repeater input frequency. Switch the receiver quickly from the repeater input to the output. If the signal sounds cleaner on the input frequency than it does on the output, it's time to reroute some of the audio at the repeater.

There are a number of places where you can pick off audio on a receiver, but none will give a signal quite as "virgin" as the discriminator. If high-fidelity audio was transmitted, you'll be able to reclaim high-fidelity audio if you get it before it gets past the discriminator.

But getting audio from the discriminator presents other problems. For one thing, the discriminator "sees" the audio before the squelch does. Which means that every time the transmitter is keyed without the presence of a quieting signal, a bothersome "squelch noise" will be transmitted. (Phone patch operation is one such case; on-site operation of the repeater transmitter is another.)

Another problem is impedance matching. The discriminator represents an extremely high impedance audio load. The transmitter audio input is apt to be quite low by comparison, particularly if input level adjustments are to be made.

Still, there is no better signal source than the discriminator, if high-quality audio is to be a criterion. And the problems aren't problems when there's a simple solution.

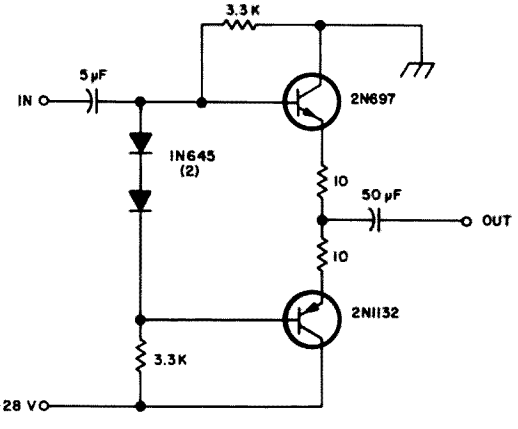


Fig. 1. This schematic from the U.S. Navy's handbook of "preferred circuits," shows an emitter follower that provides 12 dB gain. A high series resistance should be used between the discriminator and the audio input to prevent circuit loading.

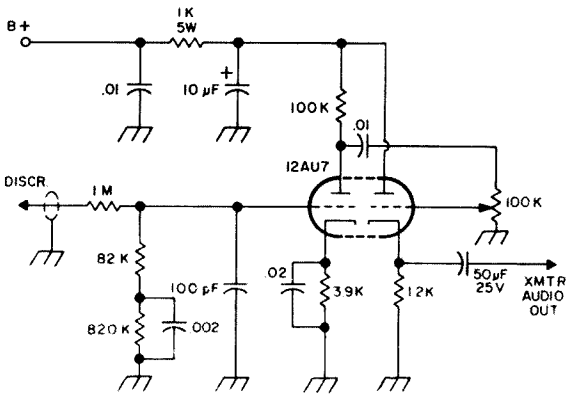


Fig. 2. This 12AU7 cathode follower is similar to the type used in commercial GE repeaters. As shown, the B+ plate supply is stabilized with a 1 kΩ resistor and filter capacitor.

Use of a cathode follower solves most of the problems. It provides excellent circuit isolation, matches a very wide range of impedances, and allows control of audio level without upsetting the receiver or transmitter audio adjustments. As a bonus, it allows completely independent local control of the repeater receiver's audio gain.

The remaining "problem" is that of discriminator "squelch" noise being transmitted when the rig is keyed without a carrier. This is solved by routing the cathode follower output to ground during all no-signal periods. The normally closed COR contacts work great for this.

The transistor equivalent of a cathode follower is the emitter follower, which will do anything a tube can do. The circuit in Fig. 1 shows an emitter-follower audio circuit that should prove ideal for repeaters with 28V dc control. (I always use −28V for repeater control because of the availability and economy of surplus 24–28V relays, and because the −28V power source can double as a transmitter bias supply.)

If no dc control voltage source is available, however, the cathode follower will probably prove more valuable. The circuit shown in Fig. 2 uses a dual triode to give one stage of amplification to the audio signal. This circuit is basically the type once used by General Electric Company in its commercially manufactured repeaters.

A well-bypassed high value series resistor, on the order of 200 kΩ, should be used between the discriminator and the cathode follower for maximum isolation and to prevent circuit "loading." In most cases the audio can be picked right off the discriminator test point, but the audio lead should be shielded to prevent pickup and processing of stray noise and audio "garbage."

The carrier-operated relay, if connected as shown in Fig. 3, does double duty by killing the receiver audio completely except when a carrier appears on the input. In this way, the repeater transmitter can be used by an on-site operator without his having to compete with squelch noise. The diode in the push-to-talk lead will prevent the COR from being triggered when the transmitter is keyed directly, and the 47K resistor provides isolation between the local mike and the audio circuit ground.

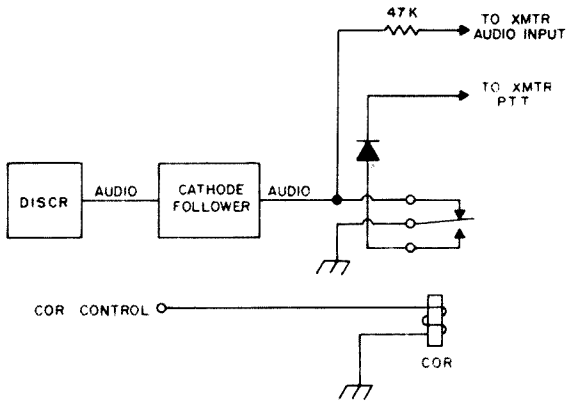


Fig. 3. The basic COR should be used to ground the receiver audio when no signals are on the input. The resistor in the audio line provides sufficient isolation so that a local mike can be used even though the audio line is grounded.

A Final Word About Quality

Repeater "listening conditions" aren't getting any better. More and more handie-talkie units are being used with repeaters, and repeater users are operating from such way-out noise sources as motorcycles, boats, skimobiles, and planes. As time goes by, repeater owners will find that effective audio will be a consideration surpassing "coverage" in importance. For after all, what good is a broad range of coverage when you can't make out the intelligence on the repeater output? But good audio *can* be built into the system. It's only a matter of taking a little extra time and putting in just a smidgen more effort.

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ATV GETTING A BETTER PICTURE

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San Pedro CA 90732

The amateur television hobby is spreading in many areas; it is interesting, challenging, and educational. Receiving these signals does not require a large outlay of money or a major constuction project; it does involve a certain amount of work and thought, since there is no appliance on the market ready for immediate use.

Amateur television transmission (A5) is authorized in the 420 to 450 MHz amateur band. In Southern California, AM (A3) stations operate on 432 (±0.5) MHz, ATV stations occupy the spectrum from 433 to 440 MHz and FM'ers use the frequencies between 440 and 450 MHz for repeater control and remote operation of lower frequency base stations.

As can be seen in Fig. 1, a typical ATV receiving station consists of a homebrew antenna, a transformer, a transmission line, a preamplifier, a UHF converter, and a TV set.

Antennas

A broadband directional antenna with a low swr and a relatively high gain (10 dB or more) is a must. A flat response of 8 MHz is necessary since TV signals are several megahertz (±4.5 MHz each side of carrier) wide and not every station operates on the same frequency. Yagis are not broadbanded devices unless the length of the elements are tapered, decreasing the gain. Collinears, skeleton slots, and log periodics meet the broadband and gain requirements. Groundplanes and similar omnidirectional antennas are satisfactory for general band monitoring but are susceptible to multi-

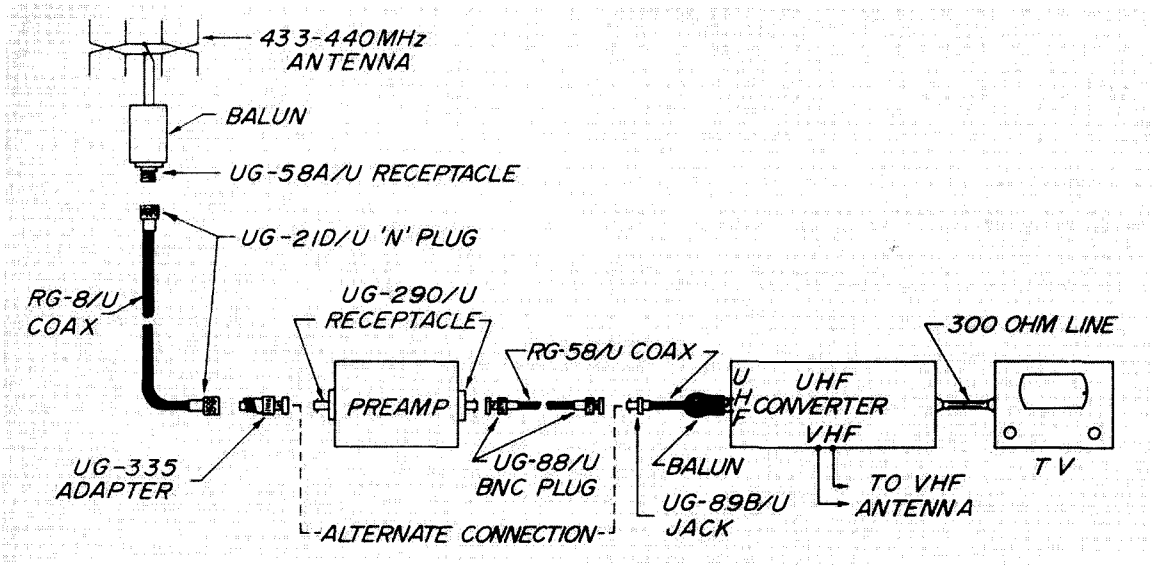


Fig. 1. Typical ATV receiving station.

path distortion and ghosts. An swr of less than 2:1 means that the antenna is matched to the transmission line and all energy is transferred efficiently. If an antenna system with a high swr is used for transmission, "ghosts" will be radiated and antenna reorientation will not solve the problem.

Most of the commercially available antennas for the ¾ meter band have turned out to be complete flops at antenna gain measuring contests. A popular brand of ¾ meter collinears has been proved totally unsatisfactory on numerous occasions due to improper match to the transmission line, incorrect resonant frequency (anywhere from 450 to 500 MHz), and short matching stubs.

A reliable workhorse in this area is the 16 element collinear shown in Fig. 2. Standing wave ratio is under 2:1 from 432 to 439 MHz, and gain is 12 dB above dipole. Check the polarization used in your area (probably vertical) and mount accordingly. Cross polarization can introduce as much as 20 dB loss, reducing the signal by two orders of magnitude!

Baluns

The antenna shown in Fig. 2 has a feedpoint impedance of 300Ω balanced. Since coaxial cable (unbalanced) is recommended, a device that will transform the impedance and convert from balanced to unbalanced must be used. Figure 3 shows two types of baluns for the ¾ meter band. The coaxial sleeve type is more difficult to

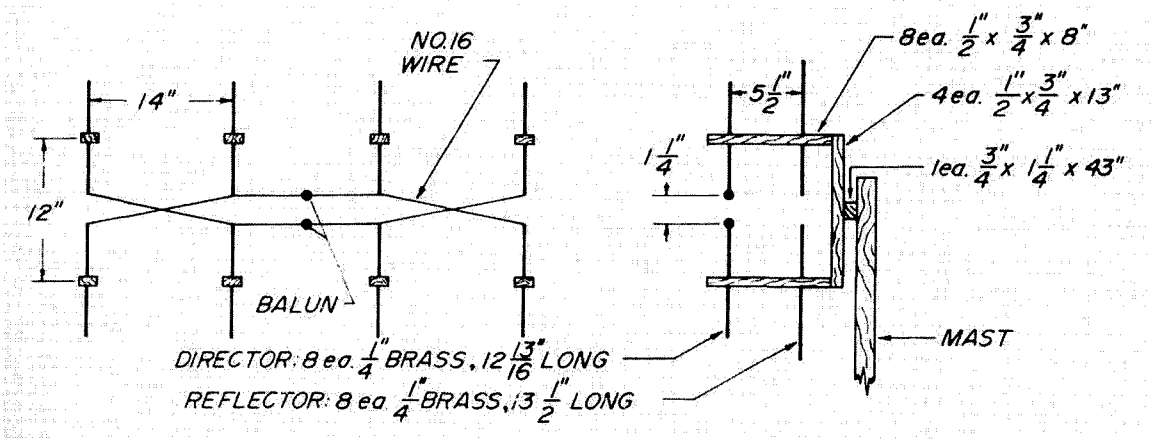


Fig. 2. 16-element collinear antenna for 432 to 440 MHz; 12 dB gain above dipole.

build, but it is more efficient and provides a better impedance match. If the antenna system is used for transmission, the coaxial line balun should definitely not be used.

Transmission Lines

Some people blindly state that coaxial cable is not good at UHF frequencies due to high signal loss and that the only transmission line to use is parallel line.

The only time twinlead or open transmission line will perform per specification is under laboratory conditions where the line is kept away from roofs and gutters, masts and rotors, walls and windows, and the humidity is 0%; anything in the vicinity of the parallel line affects its performance. In a dry lab, tubular twin lead has 3.1 dB loss per 100 feet at 500 MHz. When the line is wet the loss jumps up to 6.8 dB. Coaxial cable can be run anywhere under vitually any weather condition. At 450 MHz new RG-8/U cable typically has 4.6 dB loss per 100 feet.

If your antenna system has 50 ft of tubular transmission line, run under ideal conditions, you will gain 1 dB of signal over coax cable and you will never see the difference on a TV set! (Yes, I know that open transmission line is better than tubular, but try to work it around a rotor or wait until several birds collide with it.)

Foamed dielectric coax cables have slightly less loss than conventional RG cables, but do not always mate properly with "N" type connectors due to an oversized center conductor. This type of cable is labeled "8/U TYPE" or "foam RG-8 type" instead of RG-8/U.

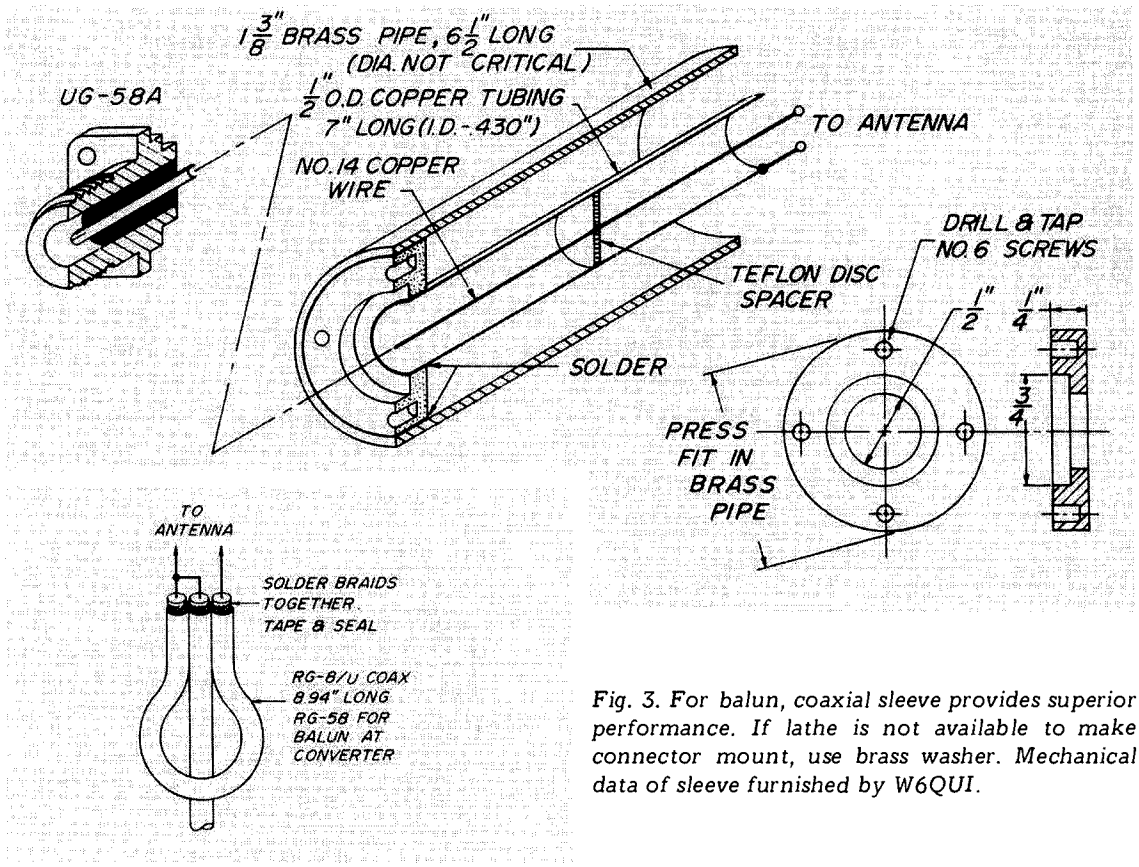
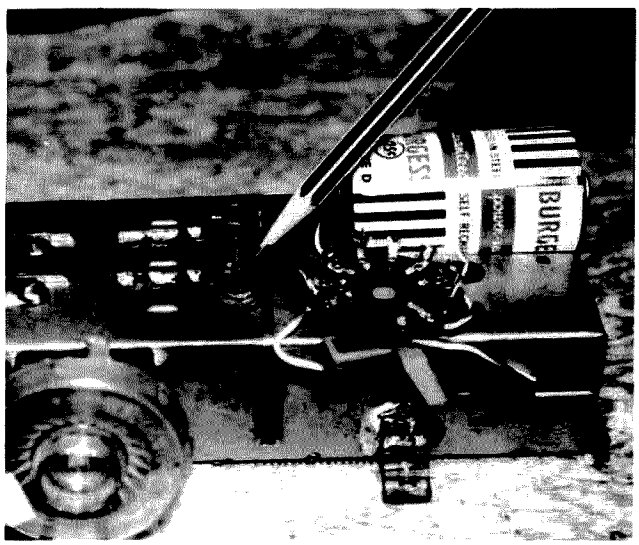


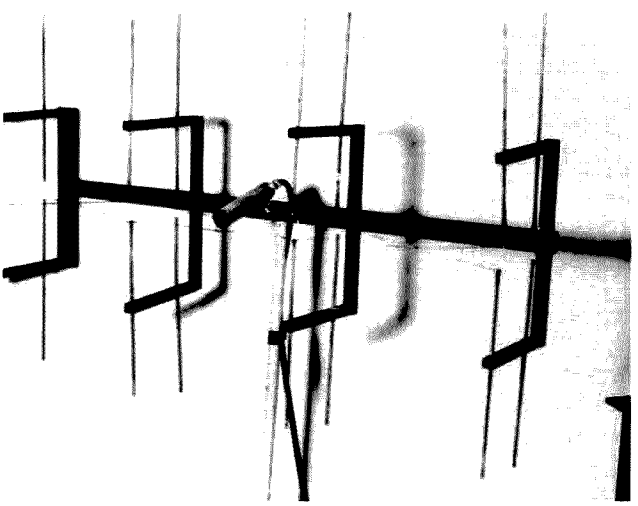
Fig. 3. For balun, coaxial sleeve provides superior performance. If lathe is not available to make connector mount, use brass washer. Mechanical data of sleeve furnished by W6QUI.

Preamplifiers

The effective radiated power of commercial UHF TV stations can reach in the megawatt category; amateur stations seldom exceed one thousand watts ERP. UHF converters have a conversion loss and noisy mixers. Even converters with amplifiers do not cure the noise problems, since the amplifier stage operates at the VHF frequencies after mixing; the converter referred to in the next section has a conversion loss of 6 dB. From the previous facts you can see that a low noise FET



Alignment screw of BTD-44 UHF converter.



16-element collinear antenna after 2 years of service.

preamplifier with at least 10 dB gain is mandatory when receiving all but local stations. Field-effect transistors (FETs) are superior to bipolar transistors due to better noise figure and less susceptibility to cross modulation.

Set Modification

The picture carrier frequency of channel 14 is at 471.25 MHz; the picture carriers in the ¾ meter band are close to 435.25 MHz, 36 MHz below the low-end limit of UHF converters. Television sets with built-in converters are not easily modified to receive ATV signals since the conversion project requires the addition of extra components within the unit, and each manufacturer has its own peculiar circuit.

A popular UHF converter in this area is the battery operated Blonder-Tongue Ultraverter, Model BTD-44. The battery lasts 6 months and keeps the cost down; and modification is simple.

When the UHF converter is hooked up per manufacturer's instructions, proceed with the following modifications:

1) Turn TV set to channel 6 (or 5 if 6 used in your area), place converter slide switch to UHF and tune in a moderately strong station between channel 20 and 30 (28 for example).
2) Remove dial, slide converter out of case, then reinstall dial so that number of tuned channel is lined up with top of converter.
3) Rotate TV set channel selector from channel 6 to channel 3 (or 2) slowly. Every time channel selector is moved one channel, retune converter for picture of channel 28.
4) With channel selector on channel 3 (or 2), peak two alignment screws on top of converter for maximum picture. Converter is now detuned 22 MHz and dial should indicate 4 channels higher than station being received.
5) Rotate converter dial 1/8 in. counterclockwise. Turn alignment screws clockwise about 1 turn each for best picture. Repeat operations until picture of channel 28 appears at a dial reading of channel 34 (or 6

channels higher than station used as signal source). The converter is now detuned 36 MHz below indicated channel.

6) Turn converter dial to indicate channel 14. The converter now receives 435.25 MHz (471.25–36 = 435.25).
7) Disconnect UHF antenna from converter and connect balun made of RG-58/U cable as shown in Fig. 1 and 3 to UHF input of converter. Connect ¾ meter antenna to balun. This is necessary since broadcast UHF antennas are not efficient on ¾ meter and are horizontally polarized.
8) Modulation bars on the third harmonic of your 2 meter transmitter should be visible on TV set.
9) Arrange with a local ATV station for a signal to be transmitted in your direction. When picture is tuned in, peak the two alignment screws for best picture.
10) Reinstall converter in case and tune in channel 28. Mount dial to indicate channel 28 below marker.
11) Tune in local ATV station and mark dial under marker.

TV Set

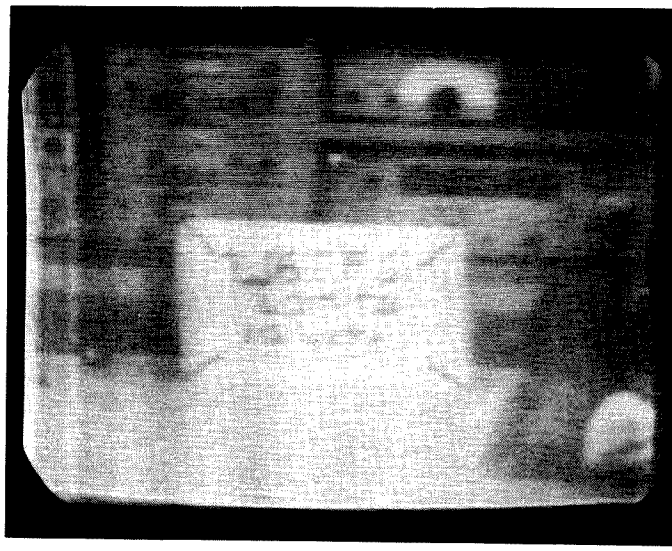
Older TV sets can be purchased for as low as $5 from stores who do a large volume of trade-in business. Insist that set be turned on for operation before buying. Do not get involved with sets that have series filaments such as portables; they are more difficult to repair in case of failure and may have a hot chassis. The sound section should also be operational since many ATV stations are transmitting sound in conjunction with video.

When the set is used primarily for ATV operation, shrink picture horizontally and vertically a little bit to give received stations better signal evaluation.

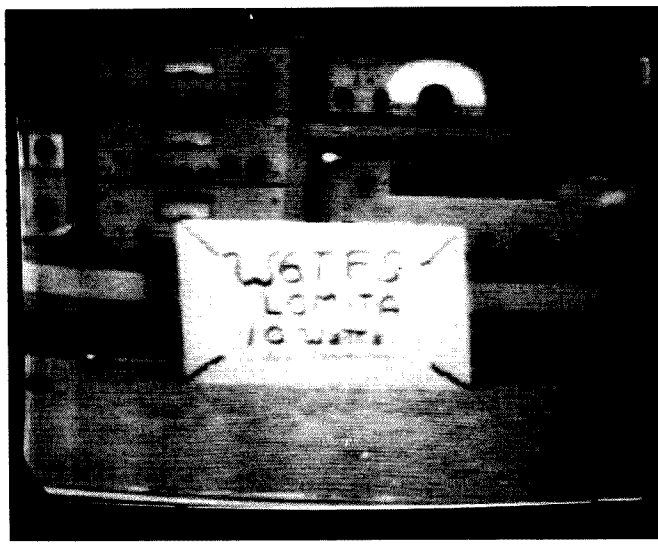
Conclusion

With the equipment described above, I have received ATV stations from all parts of Southern California, some from the other side of mountains and others as far as 110 miles away. Now it's your turn.

. . . WA6BJV ■



ATV signal received with: (a) groundplane antenna



(b) 16 element collinear antenna



(c) collinear and preamplifier



Alan Shawsmith VK4SS
35 Whynot Street
West End, Brisbane, Australia

THAT CONTEST CRAZE

An old tiger bares his fangs.

I've been in there pitchin' in contests for years – but each attempt to turn in a really big score has been abortive. Some unforeseen hitch – domestic, social, or business – has always come up.

This time – yes, I said *this time*, I was all set to pile up a mighty total. Lady Luck was going to be with me this weekend. I simply felt it, and what better companion to have on one's arm – especially the code arm.

Nothing had been left to chance. I had hired a spare transmitter and receiver, in case my anticipated 48 hours solo nonstop proved to be too much for my tired pile of junk. I climbed the tower and double-checked the beam. Sent the kids off to Gran and Gramp's for the coming few days. Tranquilized the dog in the hope it would sleep more than bark. I told the wife the house *had to remain quiet* – no parties, no engagements.

It was dark on Friday evening before I made it home from work.

"Supper ready?" I asked Helen.

She looked surprised. "Not quite. What, no stopover at the pub with the boys?"

I patted her gently where she's most comfortable. "Nope, it's into bed right after I eat. Say, are those sleeping pills still in the cabinet?"

"Yes, but aren't you making a big thing of this contest?" She eyed me suspiciously.

"Maybe, Honey, but I've got to win this one. Competition's tougher each year. Lots of young bloods coming on."

"How will you pace your fading physique against a determined 20-year-old, in a two-day scrap?"

I put on a smirk. "Guile; it's an old dog for a hard road."

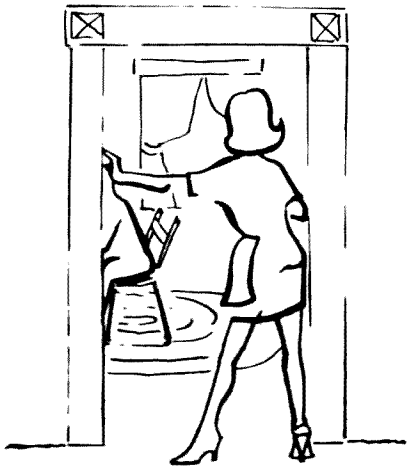
My wife looked skeptical. "You're an old dog, right enough, but a 30-year handicap. . ."

Sweet anticipation won't be turned bitter. This was to be *my* weekend and *my* contest. Even my horoscope said so. I was about to nudge the contest Greats. Write my name in ham history.

Deciding to recheck the rig before I turned in, I drifted into the shack. The band was wide open. And tomorrow, I'd be right in there with the best of 'em. An unfamiliar call came through the din. . .it was a pileup, calling on 8F3! Maybe I could just give a quick call before bed-time. . .

At 9:30 p.m., two and a half hours later, Helen tapped me on the shoulder.

"You're in a contest in the morning – remember? Or do you plan to work straight through?"



Piqued and smothering a testy reply, I rose and switched off the rig, letting the 8F3 die still unbagged under the pileup.

From the bathroom I called, "Honey, whereabouts in the cabinet are those pills? I'm hitting the hay."

"Left side, top shelf," she called back. "Small white box. There's a couple loose alongside."

"Ah, yes," I said, groping. I downed one without water.

"Ugh – what a taste. Say, do you take many of these?"

Helen poked her head through the open door. "A few. Why?"

"They're foul."

"It's your taste buds. I find them a little chalky but quite mild."

Somehow Morpheus ignored my closed eyes. Why on this night above all should the gods choose to pass me up. Drowsiness would not come and the lousy taste in my mouth persisted.

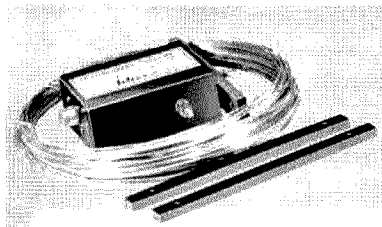
"Isn't it maddening," I said to myself, but loud enough to be overheard. "Sleep is like a coquettish woman. Woo her and she withdraws her charms."

Helen made the sounds of a person whose sleep had been disturbed.

"That pill didn't do any good; and I can still taste it," I said.

Helen rolled out of bed, stumbled over to the bathroom, and I heard her rummaging in the cabinet. Finally, she appeared with a glass of water, another pill, and a small sardonic smile playing at her lips.

"What's this – another one? Is it okay to take a second one?"



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"Swallow it," she ordered.

It tasted different. "What is it?" I asked.

"A sleeping tablet. That other pill was a distemper mixture for the dog."

"A what?" I sat up incensed. "That bloody animal has more status around here than the kids and I have. Even his medication is mixed up with ours. Is it poisonous?"

You'll be okay," she said. "Just try and doze off."

But instead of sweet dreams in the head, I developed cramps in the midriff.

"Honey," I called again after a while. "What's the time?"

"I'll bring you the alarm clock," came Helen's voice, now slightly irritated. "You can time yourself. What's up now?"

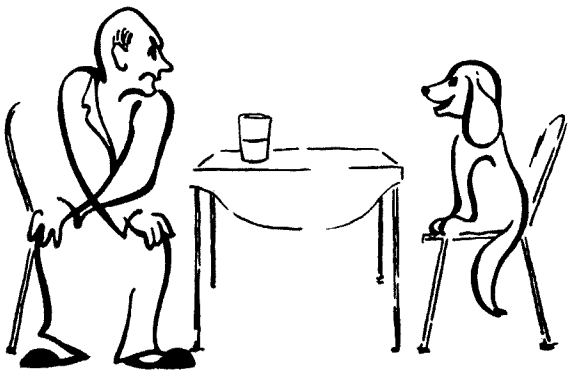
"Can't sleep and I'm queasy. Feels like indigestion or something. "Is Jack home?" (Jack is a doctor friend of ours who lives a few houses away.)

Helen parted the drapes and peered out. "Yes, there's a light on."

I tumbled out of bed to the phone and dialed.

Dr. Jack arrived; when I told him the story, he superficially looked me over and then inspected the box of dog medicine. He began to guffaw loudly.

"This prescription contains among other things a strong deworming purgative. That's what's making you ill." For some reason, he found the whole episode quite hilarious.



When he regained his composure, Jack said, "That compound is pretty rough on the intestinal tract, but it'll probably do an old dog like you more good than harm. Just ignore the discomfort and the cramps. They'll pass." Then he was gone.

Miserably, I contemplated the ceiling above the bed. With my big moment coming up, I had to go and deworm myself. A heavy slackness was taking hold of my limbs. The pill was working.

Somewhere, very faintly at first, as if at the end of a long corridor, a telephone was ringing. Not all the time, for there seemed to be breaks, but it persisted. Slowly I became aware that someone was moving near me. Helen was pulling on a dressing gown. She reappeared a moment later and threw on the light. Dazed and stupid I slowly became more conscious under its glare.

"Wassamatter, wassatime?" Even through my sophoric, phenobarbital haze I could see urgency written all over Helen's face.

"It's 3 a.m. – the fire brigade's calling you."

"Who?"

"You – go and see."

With great effort I managed to get myself slowly upright and groped for the phone.

"Is that Mr. Shawsmith? Do you have a Real Estate office in 'Gabba Lane?" I nodded, oblivious to the fact that my caller wouldn't notice.

"There's a fire in the building adjoining your business. We must ask you to come immediately."

I was so doped it hardly registered. "There's a fire. . .?"

"Yes, sir; your office is in danger."

I dropped the handpiece, unable for the moment to do more.

"Honey," I said weakly, "Will you drive, I don't feel up to it?"

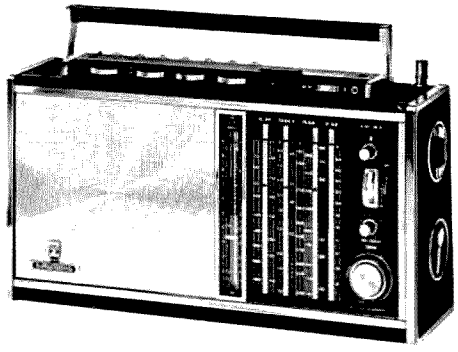
The glow in the sky was plainly visible.

At the conflagration the usual scene prevailed. Confusion, bedlam, and noise. We parked the car at the nearest possible spot and made down the lane.

"Helen," I shouted. "You grab the typewriters and take 'em across the road. I'll get some help with the safe." We made two or three sorties and removed most of the important papers and files before the heat became too intense. Water now began to pour through the ceiling and it was obvious nothing more could be done. We

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Bandspread	28.3–29.8	Longwave
Tuning	26.9–28.3	150–450 kHz
(includes CB)	20.9–21.7	
	13.8–14.5	
(includes CHU)	7.0–7.35	Broadcast Band
(SW Broadcast)	5.95–6.25	510–1650 kHz
	3.5–3.8	
	1.7–2.0	HiFi FM (Wideband)
(includes 75m)	1.6–5.0	88–108 MHz (AFC)

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stood for a while and then retraced our steps to the car only to find a young police constable, notebook in hand, pencil poised.



"This your vehicle?"

"Yes." Meekly, weakly, I answered.

"It's illegally parked."

"So are one hundred others." I swept an arm to indicate the traffic jam.

"I shall have to book you."

"It was an emergency," Helen explained. "We had just been rescuing our belongings from the blaze."

Unmoved, the cop started writing.

"You will receive a summons, but there is no need to attend court; you can simply pay the fine at. . ."

Is there anyone more infuriating than a pedantic flatfoot?

"Look," I said testily. "I don't want any instructions as regards my lawful rights. I'm more aware of them than you are. You'd do better down there helping the men." I pointed to the fire.

Helen kicked my shin. "Ssh," she whispered. "You'll finish up in the van, and that means bail money or no contest this weekend." The cop tore off the ticket and handed me a copy.

It was daylight before we slid into bed.

Hardly more than a wink went by before Helen shook me awake.

"Sixty minutes to blastoff," she said. "Thought you'd want time to snack and shower."

I lay like a slack sack. Where was my fitness of days before? Gone in the loss of a night's sleep. Dismally I contemplated the status quo. Ahead was 48 hours of bedlam and intense concentration and

already I had a pounding head. My office in ruins and a parking fine from a pin-headed cop. I cursed the fates: definitely a favorable weekend my horoscope had read.

Somehow Helen's freshness and energy provoked irritation. How could anyone be so full of bounce after such a sleepless night?

"So you're a quitter," she said. "Stop feeling sorry for yourself. A little passing 'grippe' won't kill you." My DX contest capering brings out a certain bitchiness in the old girl. It's the old love/hate complex and I still don't know after all this time if it is directed at me or to amateur radio generally. Anyway, how can a man come to terms with a woman who roots for her OM to win and at the same time disapproves of what he's doing. There's female ambivalence for you.

With a single movement she swept the covers off the bed.

"Come on," she urged. "Take a shower."

I fronted the bathroom mirror and recoiled. Helen's face appeared behind mine. "Hm, now you re vertical you do look rather ghastly. Guess you could use a little health and strength. "How about a prayer to St. Ionos. Isn't he your. . .?"

"Wrong saint," I said. "His portfolio is DX communication."

Then suddenly I remembered. "Say, Honey, there were a couple of pep pills in an old brown envelope. Are they still. . ."

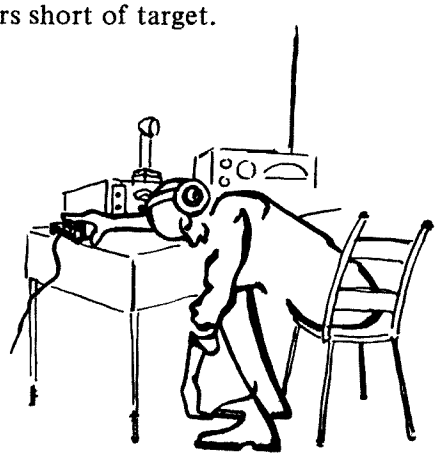
"Al, if you take *just one* of those, you can have the house to yourself for the weekend. Fools never learn."

I dragged my tired torso off to the shack and switched on the rig. As the receiver came to life a sheaf of contest forms was shoved under my nose.

"Sign these before you get under way. Last time it was a case of 'love's labor lost'; you forgot to add your signature and were disqualified."

Again I obediently did as I was bid.

Only to a contest competitor is the cacaphony of CW actually music. However, as time wears on this sweetness turns to a painful drumming in the head. The ears become more and more sensitive by the hour, until too much of a good thing turns to sheer torture. So the race dragged on. The halfway mark came and went and the pace more difficult to sustain. It was supper time on the second evening that my wife found me, like a warrior, down but still clutching the flag, sprawled asleep at the rig. Phones on head and hand on key but beaten by fatigue and age. Twelve hours short of target.



I was hauled to a divan, divested of my slippers. As Helen threw a blanket over my somnolent form, she claims I mumbled a short philosophic comment, aimed as a barb at that Yankee poet who gave us the line, "I am master of my fate." Bah! we're just flimsy straws in the windy turbulence of existence.

Epilog

One day some months later I arrived home to find Helen jumping up and down excitedly and waving a large envelope.

"Al, I knew what this was so I opened it. Couldn't wait; hope you don't mind. It's your contest award."

I read. "VK4SS OCEANIA CONTEST WINNER. Place in Top Ten W.W. No 7." "But, hey, I never sent in a log for this."

"But I did."

"You mean you wrote out my whole log. But I didn't finish the course – remember.'"

"How could we forget; you were so piqued you went QRT for a month, but I heard on the grapevine that the bands were put out by a bad solar storm several hours before the big scrap ended; so I decided you had a chance after all."

What do you say to a wife who's so smart it hurts?

. . . VK4SS ■

LOG PERIODIC

ANTENNA DESIGNS FOR UHF/VHF

William L. Nagle W3DUQ
RD-1 Box 188A
Honeybrook PA 19344

The log periodic antenna was originally designed and proved at the University of Illinois in 1955. Since then, the military has been making extensive use of this tremendously versatile antenna concept. Until recently, few in the amateur fraternity have known about the log periodic principle.

Through the use of computer-aided design, I have developed three such antennas for use in the amateur bands. The dimensions for the three are given in Table I. All three antennas exhibit a forward gain of 13.5 dB with a front-to-back ratio of better than 15 dB over the specified frequency range. The swr is better than 1.8:1 over the specified frequencies.

The first antenna will cover the range of 21 to 55 MHz; the second antenna will cover 50 to 150 MHz; and the third covers 140 to 450 MHz. These antennas are designed with a 5% frequency overshoot at the low end and a 45% overshoot at the high-frequency end to maintain logarithmic response over the complete frequency range specified. In log periodic antenna operation, approximately four elements are active at any one specific frequency, thus the necessity for the low and high frequency extensions. All three antennas are

Table I. Spacing and Dimensions for Log Periodic VHF Antennas.

	21–55 MHz Array			50–150 MHz Array			140–450 MHz Array		
Element	Length, ft	Dia, in.	Spacing, ft	Length, ft	Dia, in.	Spacing, ft	Length, ft	Dia, in.	Spacing, ft
1	12.240	1.50	3.444	5.256	1.00	2.066	1.755	0.25	0.738
2	11.190	1.25	3.099	4.739	1.00	1.860	1.570	0.25	0.664
3	10.083	1.25	2.789	4.274	1.00	1.674	1.304	0.25	0.598
4	9.087	1.25	2.510	3.856	0.75	1.506	1.255	0.25	0.538
5	8.190	1.25	2.259	3.479	0.75	1.356	1.120	0.25	0.484
6	7.383	1.00	2.033	3.140	0.75	1.220	.999	0.25	0.436
7	6.657	1.00	1.830	2.835	0.75	1.098	.890	0.25	0.392
8	6.003	0.75	1.647	2.561	0.50	0.988	.792	0.25	0.353
9	5.414	0.75	1.482	2.313	0.50	0.889	.704	0.25	0.318
10	4.885	0.75	1.334	2.091	0.50	0.800	.624	0.25	0.286
11	4.409	0.75	1.200	1.891	0.50	0.720	.553	0.25	0.257
12	3.980	0.50	1.080	1.711	0.375	0.648	.489	0.25	0.231
13	3.593	0.50	0.000	1.549	0.375	0.584	.431	0.25	0.208
14				1.403	0.375	0.525	.378	0.25	0.187
15				1.272	0.375	0.000	.332	0.25	0.169
16							.290	0.25	0.000
Boom	25.0	2.0	0.5	16.17	1.5	0.5	5.98	1.5	0.5

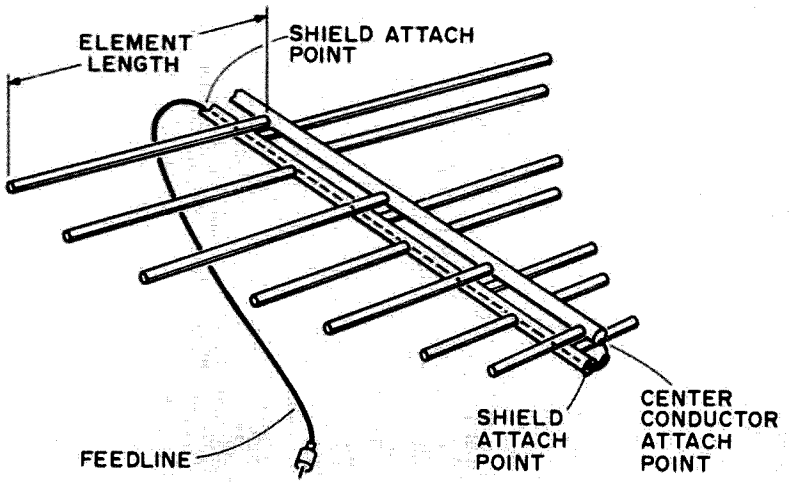


Fig. 1. Typical log periodic antenna. Note that the bottom is fed from the coax shield while the top boom is fed from the center conductor.

designed for a feedline impedance of 50Ω for use with coax such as RG-8/U. All of the antennas are design-rated for 1 kW, 100% modulated. The alpha, or logarithmic element taper is 28 degrees for all three antennas.

Construction

Construction is straightforward, and you can use your own ingenuity as far as fastening the elements to the boom, and also the dielectric spacer configurations. I used heliarc welding for securing the elements, and fiber glass for the dielectric.

Element lengths for the highest frequency antenna were calculated for the elements to be inserted completely through the boom, flush with the far wall. The two lower frequency antennas have element lengths calculated to butt flush against the element side of the boom. If the elements are to be inserted through the boom on these other two (21–55, 50–150 MHz), add the boom diameter to each element

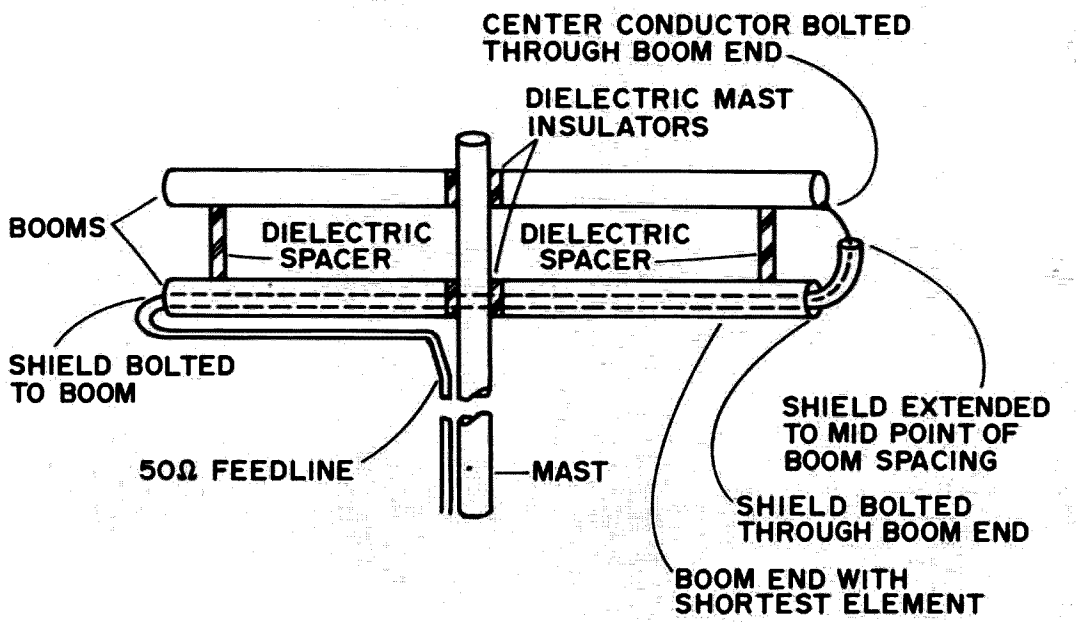
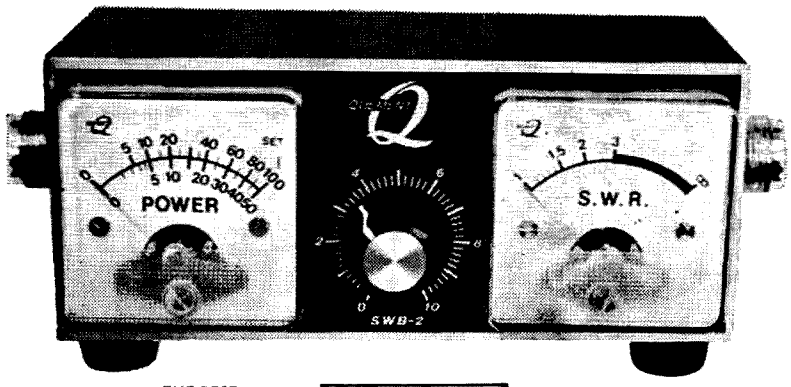


Fig. 2. Feeding the log periodic is relatively simple. Just remove the outer plastic jacket from feedline for the entire length of the boom, so that the coax shield is permitted to short itself inside the boom as well as the solid electrical connections at each end of the boom.

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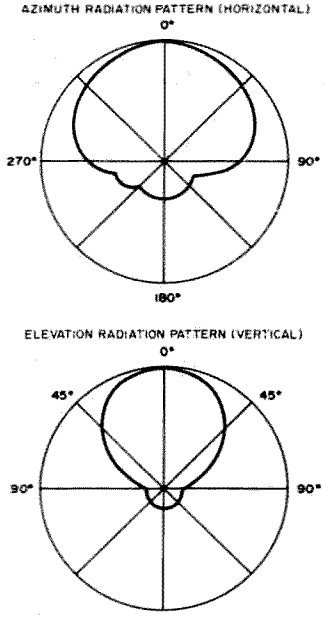


Fig. 3. Typical log periodic antenna patterns.

length shown before cutting the elements.

Two booms must be constructed for each antenna as shown in the isometric view of Fig. 1. Also remember, in supporting a log periodic antenna from a metal mast, the two booms must have a dielectric spacing from the mast of at least twice the boom-to-boom spacing; otherwise you will introduce discontinuities into the feed system.

Feedline insertion and connection are shown in Fig. 1.

Notes

Any change in the listed boom diameters will necessitate a change in the boom-to-boom spacing in order to maintain the feed impedance at 50Ω.

The location of the support mast is not critical; ideally, it should be at the array's center of gravity.

The antennas may be oriented either horizontally or vertically, depending on the type of polarization desired. The horizontal beamwidth of a typical log periodic antenna is approximately 60 degrees, while the vertical beamwidth is on the order of 100 degrees. These are the −3 dB points shown in Fig. 3.

. . . W3DUQ ■

HAM RADIO CHESS

Part I:

One of the enchantments of radio is its flexibility of application. Radio usage need not be restricted to traffic handling, ragchewing, and DX-chasing. An increasing number of amateurs are discovering the potential of amateur radio for the play of various strategic games, such as chess, checkers, and – with some adaptation – even Scrabble.

Chess is perhaps the most popular entry in the radio games category because chess by radio involves no modification to the basic rules of play and there is practically no possibility for cheating.

Radio chess is played almost exactly the same as the game in which both participants sit opposite each other at a board. The only difference is that each player has a board, and each moves his opponent's piece as directed by the opponent himself.

If you're a chessplayer, you know already that each chess piece has its own identifying name, and no other piece on that "team" bears the same nomenclature. Likewise, each square of a chessboard bears a name. Thus, a player can move his piece to the square of his choice, and then announce the move on the radio to his opponent. The opponent, in turn, makes the move as directed on his own board, then responds by making his own move and announcing it.

Part I: HAM RADIO CHESS USING ALGEBRAIC NOTATION

by Kayla Bloom W1EMV

Part II: HAM RADIO CHESS USING THE DESCRIPTIVE NOTATION

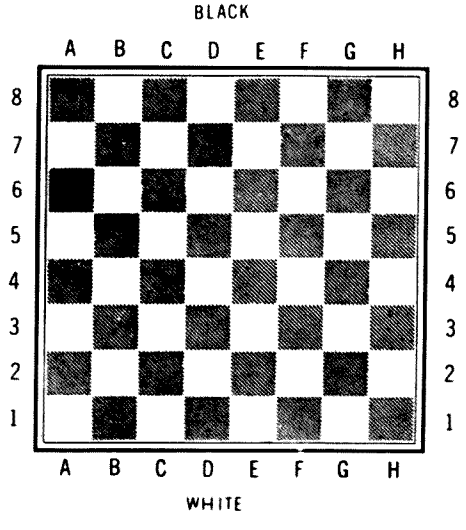
Denys G. Fredrickson WØBMW
3923 East Funston
Wichita KA 67218

Chess by radio is an ideal pastime. It doesn't tie up spectrum or airtime because the only time necessary per transmission is the time it takes to call out a specific move and get a verification from the opponent. While an amateur radio chess game may go on for several hours, there may be less than 10 minutes of accumulated transmitting time.

Most serious chessplayers are already familiar with "descriptive notation," the means by which chess moves in tournament play are recorded for later analysis and replay. Descriptive notation is the system by which each square of the board is identified according to the original piece commanding that square. While this system is easily adaptable to radio play, it is often confusing to those who are unfamiliar with chess terminology.

It also suffers the disadvantage that the squares are numbered differently for White than they are for Black; thus, when Black announces his move, White must remember not to put Black's man on his own square of the same name.

For these reasons, the matrix system (algebraic notation) is in more common general use by amateurs. With algebraic notation, the board is identified by ranks (horizontal rows) and files (vertical rows). The ranks are numbered 1 to 8 from bottom to top (from White's side); the files are identified by the letters A through H from left to right (White's side). This



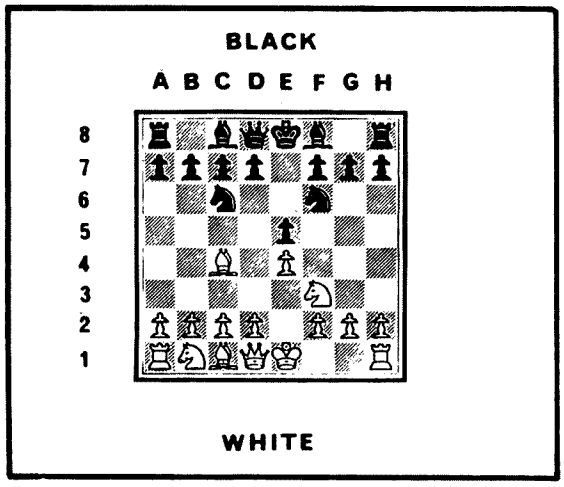
arrangement yields a matrix that pinpoints each square with a letter/number sequence.

Here's how the moves would sound in a typical opening of an amateur radio game:

1. White: "Pawn to E4."
   Black: "Pawn to E4, Roger; and Pawn to E5."
2. White: "Pawn to E5, Roger; and Knight to F3."
   Black: "Knight to F3, Roger; and Knight to C6."
3. White: "Knight to C6, Roger; and Bishop to C4."
   Black: "Bishop to C4, Roger; and Knight to F6."
4. White: "Knight to F6, Roger; and. . ."

The diagram below shows the positions of the pieces after these three initial moves. (The opening, incidentally, is called "Two Knight's Defense.")

. . . W1EMV ■



Part II:

Are you slightly bored with the general QSO? Is it so dry your lips crack and your ears become dusty? . . ."You're coming in here Q-5 by 9 plus, armchair copy. I'm running a Queenie 5, a swing-a-ling multi-element swizzle stick and the modulator gets excited by the exciter when the oscillator is in oscillation. You have a bodacious signal in here. Before I run, what's my report and your handle again? I couldn't copy." . . .A couple of these and you throw the switch.

If you would like to spend one of the most enjoyable and relaxing 45 minutes you have ever spent, then pull up a chessboard and I'll introduce you to the rapidly growing game of "chess by amateur radio." Worldwide chess at your grubby little fingertips. If you know how the chessmen move, you're qualified and eligible to play chess by amateur radio.

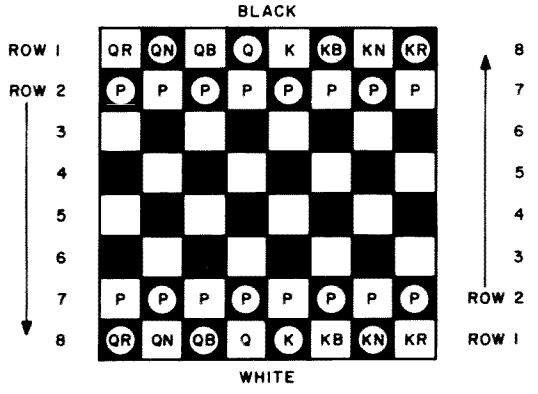
By referring to Fig. 1, you can see that the King row is number one, pawn row is number two, the next row is number three and so on across the board to eight.

Going from right to left each file is designated as follows: King-Rook file, King-Knight file, King-Bishop file, King file, Queen file, Queen-Bishop file, Queen-Knight file and Queen-Rook file. This is all that's required to properly position a piece anywhere on the board.

The important thing to remember is to accurately call out the piece being moved and to where it is positioned. If the piece to be moved is on the King side always preface the piece by saying "King" first. As an example: If the King-Knight were to be moved, one would say: "King-Knight to King-Bishop three" or King-Pawn to King four," or: "Queen-Bishop to King-Knight five."

If you don't know what Knight it is (or day), you will have to set up another

schedule... I mean if you are confused about what knight you are talking about, then state that you are moving it from a particular position to another. Such as: "Knight at Queen-Bishop four to King five."



When there is only one pawn that can capture another piece, you can shorten it by simply saying "pawn takes pawn" or whatever. As you get into the game, numerous shortcuts will be evident. It is also advisable to make a note of each move so if an error should develop you will know how to back up or correct it. The note is a simple "KN-KB3" which reads King-Knight to King-Bishop three. Keep your moves and your opponent's moves listed opposite each other and numbered for easy reference.

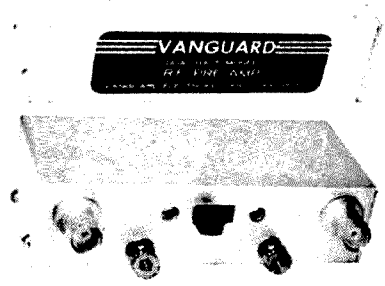
I had an amateur television station in operation for the sole purpose of playing chess by TV, but have so far been unable to get anyone else interested in ham TV. I will build another TV station if someone else is interested.

Most of the chess players have been getting together above 14.3 MHz and on 7.250 MHz in the evenings and on Saturday and Sunday afternoons.

If you don't enjoy the time spent playing a game of chess, I will head for the castle on my knight and become a pawn in the court of the King and Queen with the blessing of the Bishop and that's what you call a stalemate. "Try it for kicks"...it's better than "dope." Or maybe it should read: "Dopes should try it for kicks."

... WØBMW ■

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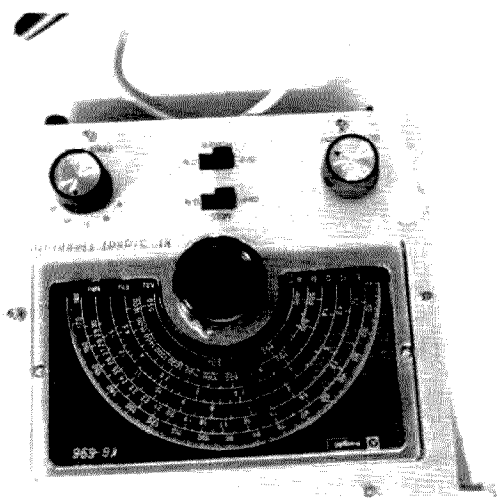
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Knight Kit KG-696 RF Generator Kit Review

Elliott Kanter W9KXJ
3242 W Hollywood Ave
Chicago IL 60645

We hams pride ourselves in being equipped for just about any emergency that comes up; but for those times while mountain-topping or operating mobile, when we need a source of rf, we are prone to make do with something less than optimum. I know that I had always wanted a good rf signal generator, but I didn't want to be tied to ac power lines. I did something about my wish and latched on to Allied's KG-696 battery-operated rf generator covering from 400 kHz through 30 MHz.



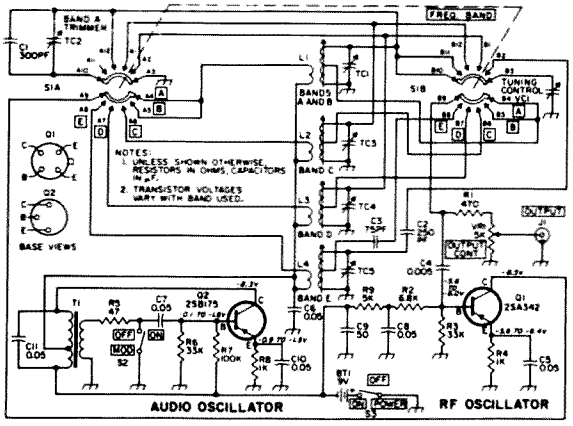
The Knight-Kit KG-696 rf generator showing molded cable assembly.

For those of you who follow changes, the Knight-Kit line has been shifted to Japan and the oriental influence is evident in this little gem. The generator consists of two transistors, a PC board, and a handful of quality components which together make up an interesting package in the less-than-$20 range. The generator contains two separate circuits: an rf oscillator and an audio oscillator.

The frequency selector switch selects one of four rf coils to provide signal output on five bands. The lowest frequency range (400–550 kHz) utilizes the rf coil for the 550–160 kHz band with the addition of some capacitance across the coil to permit tuning 400–550 kHz. Each of the four rf coils features adjustable cores and trimmer capacitors for precise alignment.

The base of the rf oscillator transistor is connected through a capacitor and the band selector switch to a tap on the selected rf coil. This is done to hold transistor loading to a minimum across the coil and provide a high-Q tuned circuit. Feedback necessary for oscillation is provided by a switched secondary winding on each rf coil.

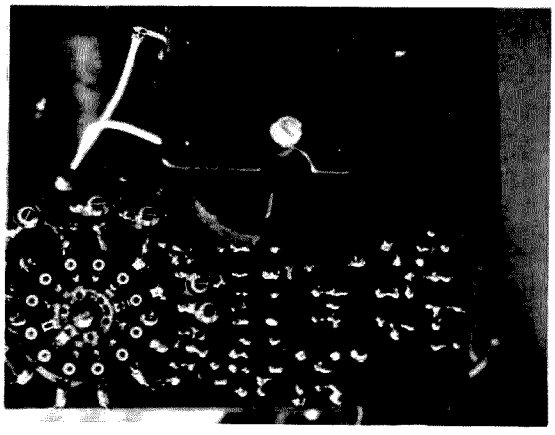
The audio transistor functions as an oscillator generating a 1 kHz signal. A switch allows selection of pure rf or rf modulated by the 1 kHz note. Construction assembly requires approximately four hours with about one additional hour for alignment. A well written and illustrated text aids the new kit builder and proves a valuable aid to the more expert construc-



Physical Size:	5 7/8 x 5 7/8 x 3 5/8 in.
Weight:	2 lb
Freq. Coverage:	Band A- 400-550 kHz
	Band B- 550-1600 Khz
	Band C- 1.6-4.5 MHz
	Band D- 4.5-13 MHz
	Band E- 12-30 MHz
RF Output::	Over 100,000 μV
Modulation:	1000 Hz
Audio:	1 kHz, adjust. intensity
Battery:	9V Eveready 216
Price:	$19.95

Schematic diagram of Knight-Kit KG-696 rf generator and specifications.

tor. The majority of the circuitry is wired to a PC board of first-rate quality, featuring a unique application for converting a conventional wafer-type rotary switch to a PC-type component.



Interior view of PC board highlighting converted switch mounted to PC board.

As the photograph illustrates, the last deck of the switch is soldered directly to the PC board. This is accomplished by first disassembling the switch and reassembling it with the bottom wafer flush against the PC board. This simple operation is secured with somewhat oversized hardware and provides a convenient method of achieving the versatility of a PC-type switch with the economy of conventional components. This technique can and probably will be adapted for use in many amateur homebrew projects. Conventional wiring techniques are used for the other connections to the switch.

At times construction became a bit "hairy," as space was at a premium, but the entire generator rapidly took on the appearance of a mechanically and electronically stable piece of ham gear with no major problems.

Battery replacement, frequently a problem with solid-state gear, is simple. The battery (9V transistor type) is held in a clip with conventional snap-on terminals. This clip is part of a bracket secured to the bottom of the case with the battery inside.

Alignment

The entire alignment procedure is based on the use of standard broadcast station frequency reference points for the range from 600 to 1600 kHz, and a ham receiver for checkpoints on the higher bands. Shunt capacitors are included in the event the core adjustment and trimmer adjustments fail to bring the unit to satisfactory alignment. A small quantity of wax is included to be melted and deposited in the cores and on trimmer screws to prevent movement once alignment is complete.

Comments

The KG-696 represents an inexpensive means of achieving a reliable source of rf and is portable and nondependent on ac power lines. It is useful for on-site adjustments as well as a reliable fixed-station performer. Its price – less than $20 – puts it in the buying range of many of our newer hams who, though never short on ideas, are often short on capital.

. . . W9KXJ ■

Dick Brubaker
Applications Engineering
Motorola Semiconductor Products, Inc.
Phoenix, Arizona 85036



A VHF AM USING LOW-COST TRANSISTORS

TRANSMITTER

This report describes a broadband VHF AM transmitter that has an output power of 4W over a range of 118–136 MHz with an rf input of 5 mW. It requires no tuning in changing frequency.

Though the transmitter is not designed for amateur use, it illustrates many principles of interest to hams, and it could probably be retuned for the 2 meter band.

The transmitter operates from a 25V dc supply; the rf circuitry is designed for operation from a 12.5V supply with collector modulation and the 25V dc requirement is due to the series modulation employed. The modulator described in this report does not require a modulation transformer, yet provides upward modulation of over 90%. In cases where it is necessary to operate the entire transmitter from a 12.5V dc source, a conventional modulator utilizing a transformer could be employed.

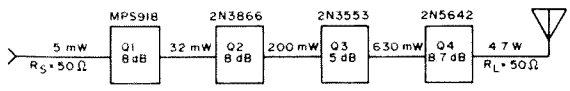


Fig 1. Block diagram of 4W VHF AM transmitter.

This note includes sections discussing the transmitter circuit and performance, design considerations, circuit layout, and testing. An additional section is included describing the modulation system used.

Circuit Description

The transmitter consists of four common-emitter amplifier stages. The block diagram is shown in Fig. 1.

The output stage (Q4) uses a Motorola 2N5642 balanced-emitter transistor (BET). These transistors were developed by Motorola to eliminate failures common in earlier rf power transistors; BETs are highly resistant to secondary breakdown due to mismatching and detuning. The 2N5642 is mounted in the stripline opposed-emitter package, which provides low-impedance strip connections and excellent isolation between the base and collector. The package is shown at the left. All terminals are electrically isolated from the stud for ease of mounting. The 2N5642 is capable of 20W output in CW or FM service, but must be downrated for AM use.

The input amplifier (Q1) is a plastic-encapsulated MPS918 transistor in the TO-92 Unibloc package. Detailed specifications on these transistors are available in the Motorola Semiconductor Data Book, or from individual data sheets.

The driver stage (Q3) uses a 2N3553 and the predriver (Q2) uses a 2N3866. These are small rf power transistors in the TO-39 package.

Amplitude modulation is applied to stages Q2, Q3, and Q4 with the supply voltage to Q3 reduced slightly with a small series resistor. A separate unmodulated dc voltage (12.5V) is applied to Q1. Two

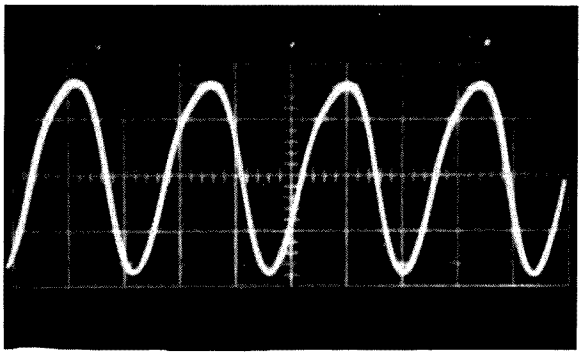


Fig. 2. Output carrier at 136 MHz (V_{CC} = 12.5V).

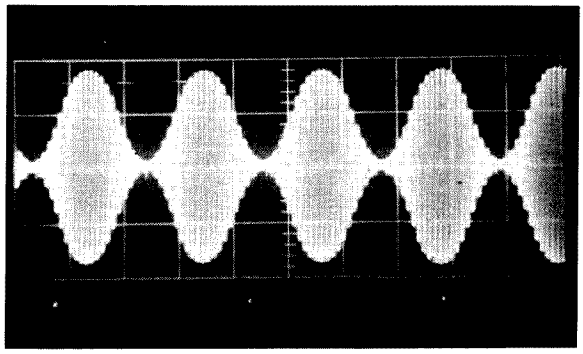


Fig. 3. Composite modulated output signal at 136 MHz (V_{CC} = 12.5V). Modulating frequency: 1 kHz.

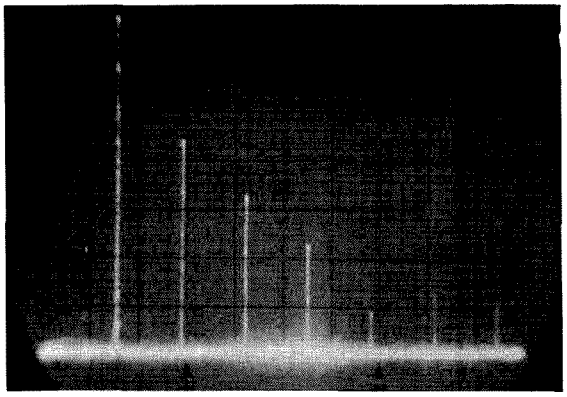


Fig. 4. Output spectrum with 136 MHz carrier (VCC = 12.5V).

diodes are used to limit the downward modulation to Q2.

Circuit Performance

Typical performance data for the transmitter is given in Table I. The driving source is a standard signal generator with a 50Ω output impedance.

The actual output waveshape at 136 MHz monitored by a sampling oscilloscope is shown without modulation in Fig. 2 and with modulation in Fig. 3.

Figure 4 shows the frequency response of the 136 MHz carrier on a spectrum analyzer. The spurious response data and output power shown were measured without an output filter.

Design Considerations

As previously discussed, the overall objective of this transmitter is a broadband modulated output. That is, the transmitter must be capable of being modulated in excess of 85% from 118 MHz to 136 MHz

	136 MHz
Power output, unmodulated (rms)	4W
Power output, modulated (rms)	5.9W
Power supply voltage (at collector of Q4)	12.5V
Power supply current (total)	530 mA
Collector current, Q4	400 mA
Power input, unmodulated (rms)	5 mW
Typical upward modulation	97%
Envelope distortion	7.9%
Harmonic Output:	
Second harmonic frequency	-24 dB
Third harmonic frequency	-35 dB
Other frequencies	-40 dB
Spurious sideband output for f_m = 1 kHz:	
Sideband amplitude at second harmonic of modulating frequency	-23 dB
Sideband amplitude at third harmonic of modulating frequency	-32 dB
Sideband amplitude at fourth harmonic of modulating frequency	-44 dB

Table I. Performance of Broadband Transmitter.

with a minimum power output of 4W; consequently, any circuitry or device used must be considered from the viewpoint of broadband modulated output rather than narrowband unmodulated output. Considering first the devices, a primary requirement here is overdrive. That is, each stage must be slightly overdriven to achieve the desired bandwidth. Since each stage is overdriven, the overall stage gain is less than that potentially possible in a normal narrowband test circuit.

Another important consideration involves the interstage networks used to transform the input admittance of one device to the required collector loading of a lower level device. Although circuit Q is important, stability and upward modula-

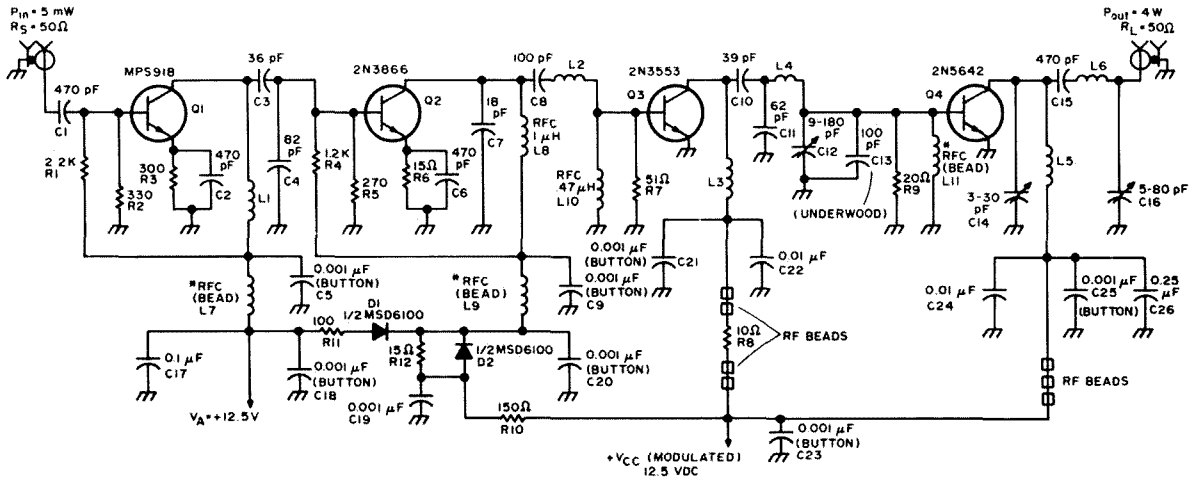


Fig. 5. Schematic diagram of broadband AM transmitter.

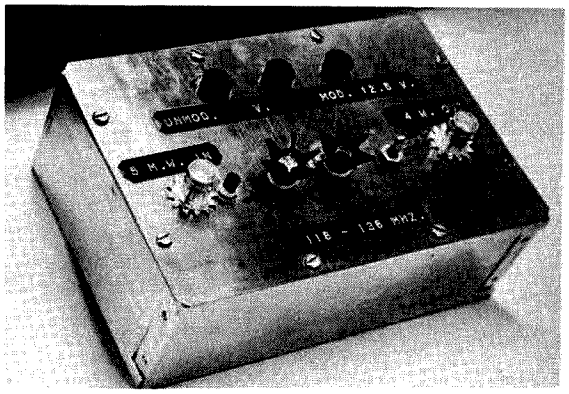


Fig. 6. Top view of transmitter.

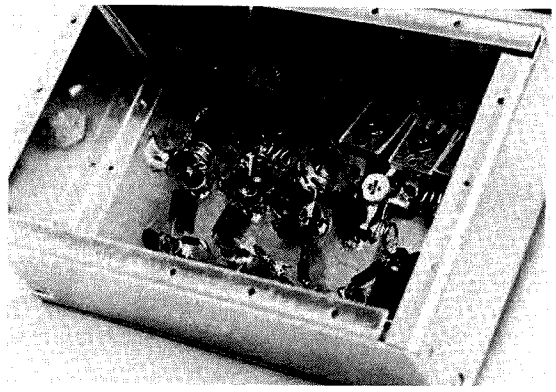


Fig. 7. Bottom view.

tion capability are equally important. One approach that can be used is to design a tentative network at mid-band (127 MHz) for a Q of 1. Incidentally, it should be pointed out that the large-signal admittance data shown on most rf power transistor data sheets is for narrowband design only. Any design involving an overdriven stage is an approximation. The circuit values can then be optimized in each network by driving the transmitter with a modulated power sweep generator.

A brief description of each stage is as follows. First, the 50Ω load is transformed to the collector of Q4 with a *pi* network. The required drive power to Q4 is approximately 630 mW for an output power level of 4.7W. The input to Q4 uses a large capacitor from the base of Q4 to ground to tune out the base lead inductance. A low-inductance capacitor is highly recommended.

The driver stage (Q3) is also collector-modulated with full upward and downward modulation. The drive level to Q3 is approximately 200 mW.

The predriver stage (Q2) is also collector modulated; however, it is primarily modulated upward. The downward modulation is limited by diodes D1 and D2. Diode D2 does not conduct during the downward modulation cycle, so Q2 is only upward modulated. When D2 is not conducting, D1 conducts and provides Q2 with a constant 12.5V supply. Both diodes are contained in one plastic-encapsulated package (MSD6100).

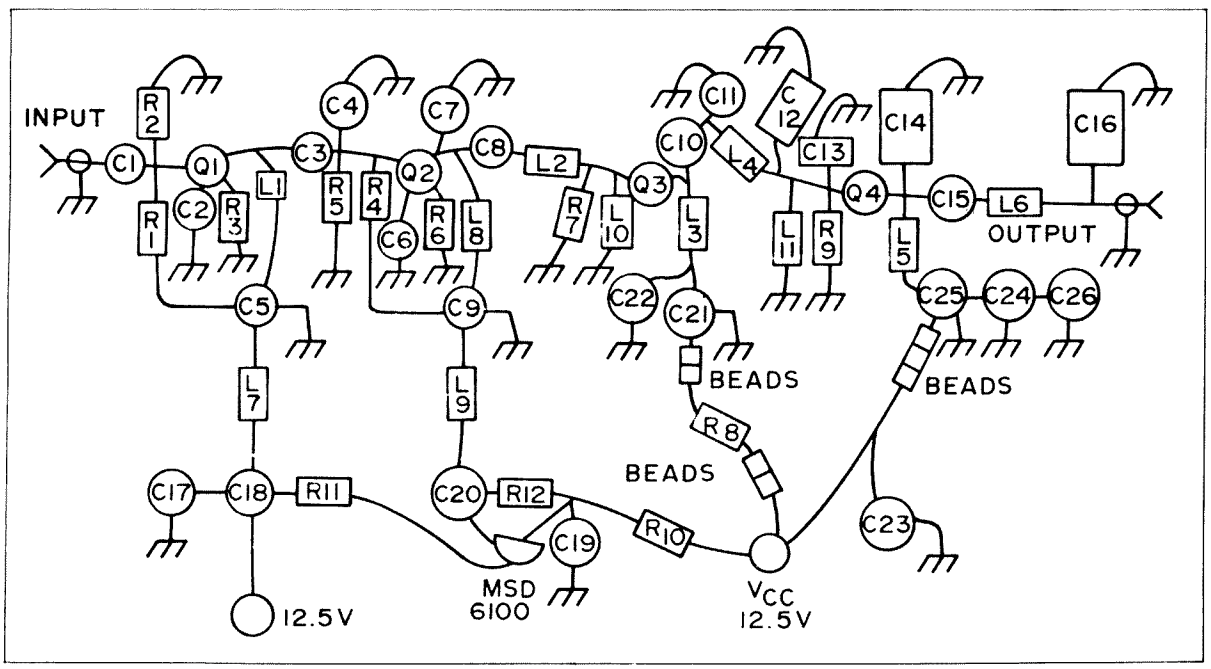


Fig. 8. Suggested component layout.

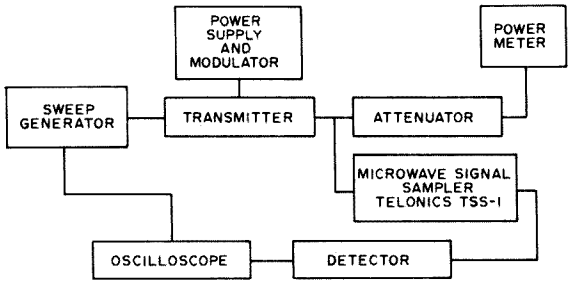


Fig. 9. Block diagram showing power sweep test.

The required input power to Q2 is 32 mW.

The input stage (Q1) is operated class A with no modulation. To insure that no instability occurs, this stage should be driven from a 50Ω source.

Circuit Layout

Careful attention must be paid to circuit layout. Figures 6 and 7 are top and bottom views of the transmitter, and Fig. 8 provides a layout of the components used in the transmitter.

The circuit is constructed on a 6 x 3¾ in. phosphorus–bronze metal plate 1/32 in. thick. The first three stages (Q1, Q2, and Q3) use sockets. The output stage (Q4) is stud-mounted directly to the chassis.

Test Setup

An important consideration in testing as well as the component optimizing of the transmitter is the test setup. The block diagram shown in Fig. 9 shows a power sweep technique. The primary advantage of this approach is that the results of individual component changes can be observed over a wide frequency range rather than simply at an individual frequency. Consequently, two important factors important in wideband transmitters, bandwidth and instability, can be observed across the band.

A sweep generator drives the transmitter. If drive power in excess of that

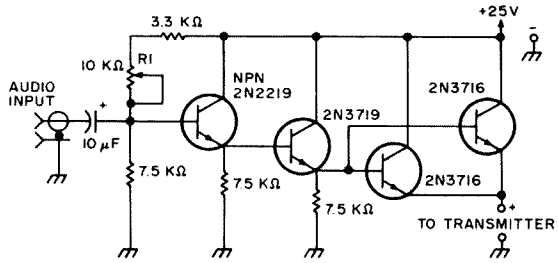
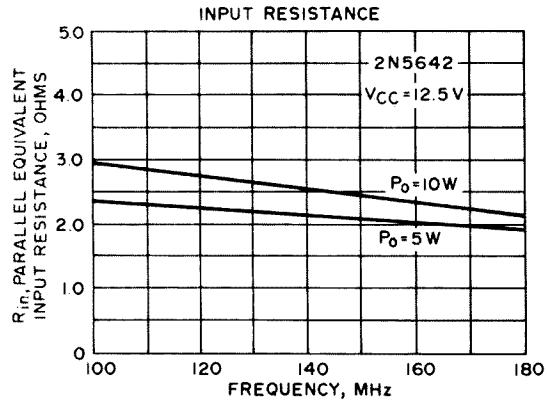
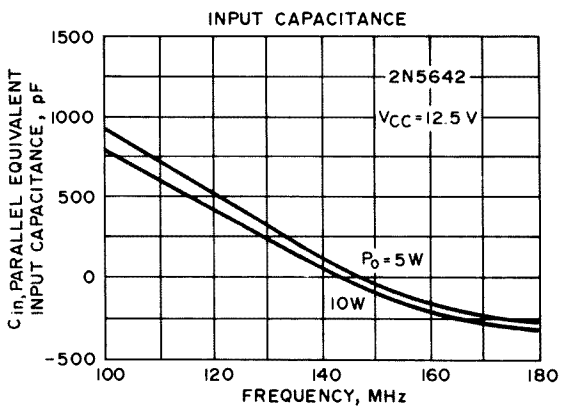


Fig. 10. Series modulator for 4W transmitter.





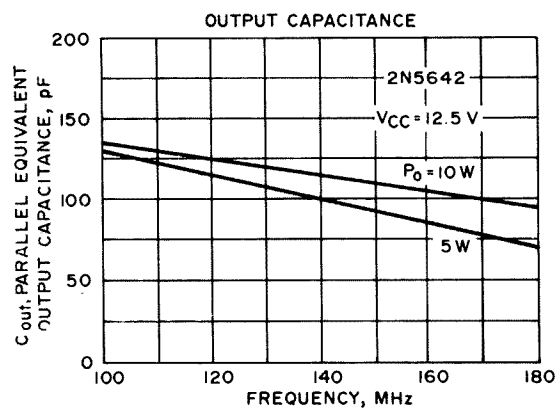
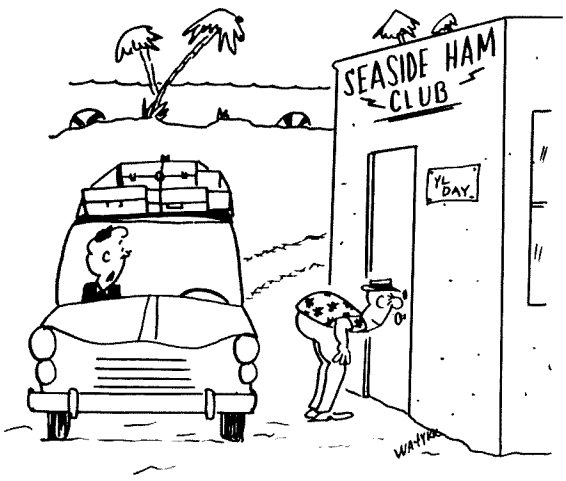


Fig. 11. Impedances of 2N5642 with 12.5V collector supply.

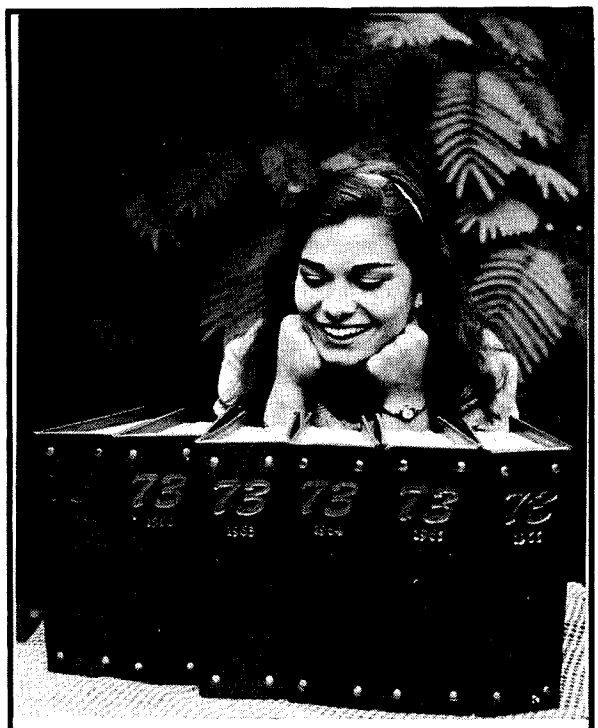
obtainable from the sweep generator is required, another transmitter can be used; that is, the sweep generator can be used to drive a transmitter, which in turn can be used to drive the circuit under test. This approach can provide high-level modulation; the transmitter supplying the drive power can also be modulated upward.

Modulation

Collector modulation usually requires a significant amount of audio power in conjunction with a large collector current. Consequently, if a transformer is used, it



"Can't you forget for two weeks out of the year that you're a ham!"



Buy 73 binders and win the love of a beautiful girl. Now only $4.00!

must be capable of operating with a large collector current circulating through its secondary winding, as well as supplying the required audio power. In addition, the transformer should furnish the required impedance-matching low distortion and low dc resistance in the secondary, since a significant dc voltage drop across the secondary winding will reduce the effective dc voltage applied to Q4.

An alternative approach is shown in Fig. 10. This method utilizes an audio power transistor instead of the transformer secondary. The collector supply to the modulator is 26V. The dc voltage to the transmitter is adjusted with R1. Although this modulator has several disadvantages such as thermal drift and distortion, it nevertheless provides a convenient method of modulating a transmitter. A more practical series modulator could include external feedback to reduce envelope distortion. The modulator shown in Fig. 10 has a harmonic distortion less than 1%. The modulator shown has been used to modulate transmitters with unmodulated carrier powers up to 35W.

Figure 11 includes three characteristic charts for the 2N5645 with 12V collector potential.

Acknowledgment

The author wishes to thank Ed Loupe for his many useful suggestions and comprehensive laboratory data generated in conjunction with the design of this transmitter.

Brubaker ■

References

1. "Matching Network Designs with Computer Solutions," Motorola Application Note AN-267.
2. "Systemizing RF Power Amplifier Design," Motorola Application Note AN-282.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

Joseph M. Pleasich W8DYF
RD 1
Irondale OH 43933

RAISING a RHOMBIC

Me! Put up a rhombic?"

"Why not?" said Vince, "After all, you already have the toughest part of the job done."

"I do?"

"Sure. You've got three acres on top of a hill."

And this is how my rhombic began. Vince, K8LQM, our club treasurer, who is affectionately kidded about being K8L*QRM*, kept reminding me about what a shame it was for a ham to have all that land, and yet not have it covered with antennas.

I had to admit it. Ol' Vince had me thinking. I even started to have visions of DX calling me instead of vice versa. Anyway, after more encouragement from Vince, I decided I'd give it a try.

A-Frame Construction

Vince and I decided to make my rhombic 137 feet on a leg. Why this size? Simple. It would fit nicely within the property boundaries of my back yard.

Since I did not have any strategically located utility poles, trees or towers, and did not wish to spend much money to purchase any, my next question was "How do we support all that wire?"

"Easy." he replied in a tone that was just a little too nonchalant for me. Vince took pencil and paper in hand and sketched the 40 ft A-frame mast shown in Fig. 1 and the photographs. Although many articles say that the top section of the A-frame can be made of 2-by-3s, we used only 20 ft 2-by-4s. It may not have been necessary, but they were available, and we liked the added strength and rigidity it gave to the completed mast. Also, don't forget to run bolts through the bottom of each leg of the A-frames as shown in the illustration. This will keep the legs from splitting.

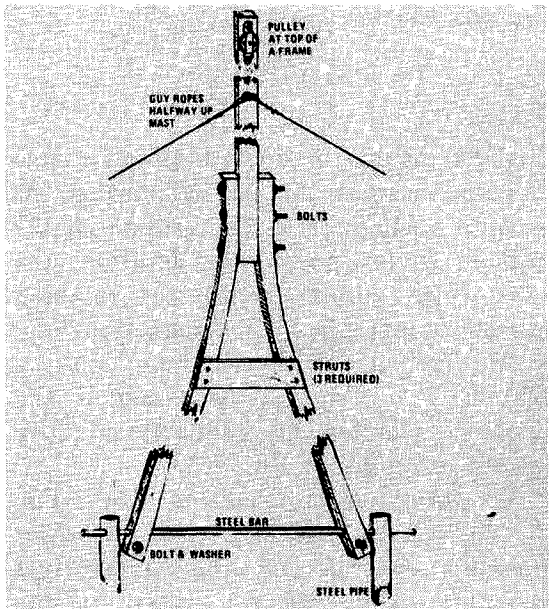


Fig. 1. A-frame construction details.

Next, I felt I'd like to be able to get these A-frames up in the air with a minimum of fuss and manpower. Again, Vince had the answer. Pivot them. This we did, as shown in the illustrations and photos. This system enables two men to "walk up" without much trouble at all. In fact I – weak ol ' pencil pusher that I am – was able to steady it all by myself while Vince tied down the guys. Even if you are not going to put up a rhombic, the A-frame



Vince (K8LQM) gets the soft job of putting the A-frames together while the author sweats over the picture-taking chores.

makes a dandy, inexpensive support for an inverted vee, VHF beam, or both.

Once the first A-frame was built, it certainly wasn't any problem to make three more of them. In fact, Vince and I were able to drill the holes and bolt them together in about 20 minutes.

When the A-frames are completed, put a couple of coats of paint on them. You can raise them up off the ground and lay them across two or three sawhorses and make the painting job a lot easier.

Vince thought it would be a good idea to paint each A-frame with a different color in a barberpole design. I painted them white. After all, they can be seen for two miles as it is, and how would it look if a high-school guidance counselor were hauled off to the happy farm for having psychedelic poles in his back yard.

To the top of each A-frame we attached pulleys, and passed ropes through them. Finally, we attached the guy ropes. Then, when we swung them up into the air, all we had to do was fasten the guy ropes to stakes in the ground. After all the A-frames were standing, we attached an insulator and antenna wire to the pulley ropes and pulled the antenna into the air. (With this rope-and-pulley system, minor tension adjustments are very simple to make.)

Feedline Construction

If you are still with me, you are probably asking yourself, "Now that that nut has that monstrosity up, how does he feed it?" Well, I should feed it skeptical, unadventurous hams, 6 meter beams, and XYLs, but I don't. I feed it with open-wire line as shown in the illustrations. How long is it? It's just long enough to reach the transmitter – which, in my case, is about 130 ft.

I made the feedline out of 14 AWG wire and 3/8 in. dowels. Since I had plenty of it available, I used 18-gage copper-clad steel wire to attach the feedline to the spreaders as shown in the illustration. This made my ladder line so strong I could almost climb it.

Perhaps you are wondering why we made the feedline 9 inc wide. Well, the dowels came in 3 ft lengths. Not wanting to waste anything, we just cut them into 4 equal 9 in. lengths. It works fine!

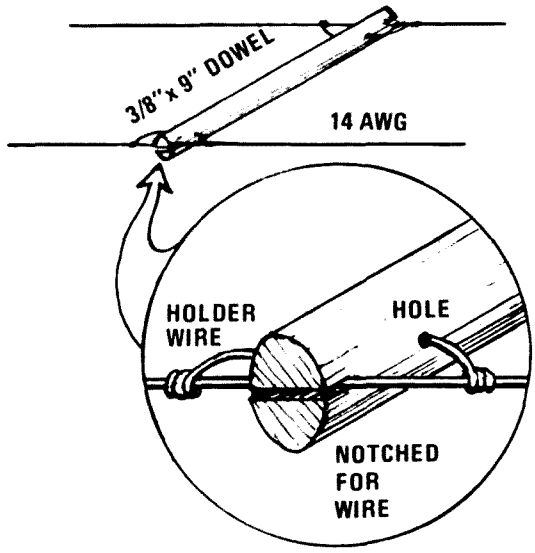
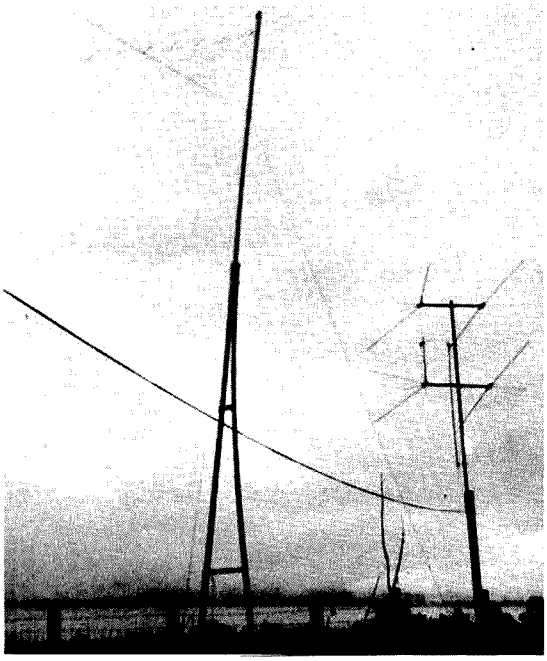


Fig. 2. Feedline construction.



This is the author's method for bringing the ladder line into the shack.



A "ladder line" open-wire feeder carries the signal from the house to the feed point on the nearest A-frame.

Especially if you have never used open wire before, you will have to figure out a method for bringing this type of feedline into the shack. I live in a frame house with the shack located in the basement. My method is the one shown in the illustrations and photos. Purists might disagree with it, but, again, it works for me.

Operation

The biggest test of all, of course, is its performance. First, though, let me give you the equipment lineup. The rigs in use at W8DYF are Hallicrafters SR-42, Heath HW-16, Drake TR-3, Johnson Matchbox, and a Knight bridge.

Using one configuration or another on the Matchbox I have been able to load the antenna on phone and CW on every band. I can't give you any gain figures, but a couple of VKs and ALs have told me I have a very good signal for 300W PEP barefoot. A WØ in Denver told me I had the needle on his S-meter shoved up as far as anyone has ever put it. Frequently, when ragchewing, fellows will break in just to tell me what a good signal I have.

Every Sunday at noon I work W8ZRI/4 in North Carolina. He usually gives me a report of 55 to 60 over. Even field day did not interrupt our schedule. We just talked right through that mountain of QRM!

One thing I am going to try is putting a terminating resistor at the far end of the antenna so that the pattern will be broader, for I do find it to be pretty sharp. For example, one night after the skip had gone out on 10 meters, I called W8DRW, a good friend of mine who lives about 18 miles south of me. He could barely hear me. However, when I tied the feeders together and fed it with the Matchbox as a random length of wire, he was comfortable copy.

I've also been using the antenna with my SR-42 and a homebrew antenna coupler on 2 meters. It seems to work fine, but seems to be pretty directional.

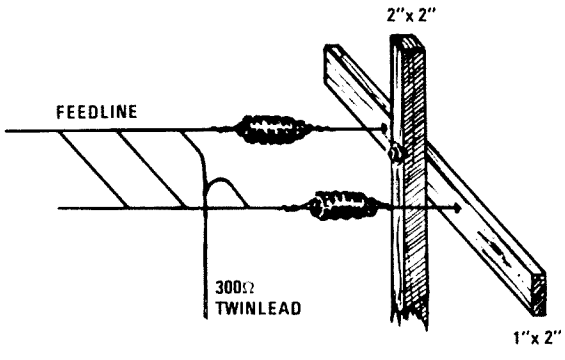


Fig. 3. Feed point details.

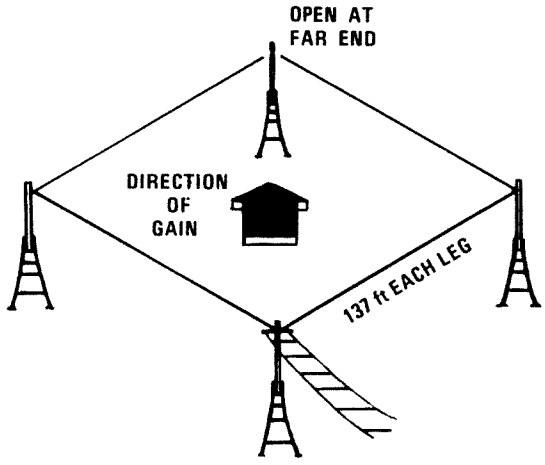


Fig. 4. Layout of raised rhombic.

All in all, I'm very pleased with the antenna. It is rather inexpensive and it permits me to operate over a wide variety of frequencies with only one antenna. Also, it's quite a conversation piece on the air. So even if you can't raise your own rhombic, I hope I've given you some ideas for a QRM killer of your own.

. . . W8DYF ■

HERE'S THE ANNOUNCEMENT YOU'VE BEEN WAITING FOR!

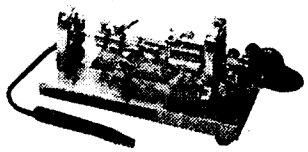
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LEAKY LINES *(cont. from page 12)*

Why, then, are devices like can openers and electric blankets not equipped with condensers at the time of manufacture? Again, it's dat ol' debbil, money!

Despite my seeming tongue-in-cheek jocularity in this piece's opening gambit, there's a kernel of serious purposefulness in my statements. I really cannot for the life of me understand why the FCC, which has tremendous influence in all phases of the electrical and electronic manufacturing field, does not put some real teeth into some specification requirements. If any electrical device fails to meet acceptable standards with respect to interfering radiations, a temporary injunction could easily be invoked, enjoining further production until the problem is overcome. This is no more radical than the control of production in the food and drug categories, when health is imperiled as a result of substandard operations. After all, a few cents' worth of components would not impoverish these companies, or cut seriously into their profits, notwithstanding the copious crocodile tears and their howls of anguish whenever they speak of production costs. A cursory glance at the figures on corporate earnings will disclose that these industrial firms, in the main, enjoy lucrative returns on their investments. Chiseling on the price of equipment, for that is what this amounts to, is simply not justifiable on the grounds of economy. Such economy, if it is not passed on to the consumer in the form of lower costs, is really nothing, more or less, than a way to increase profits.

Why not an approval stamp, issued by FCC, attesting that the appliance is free of interfering radiations, and meets proper standards? Why not an industrial-wide code establishing such standards? We have grown used to the endorsement of the Underwriter's Lab, which reassures us as to safety from shock and fire hazard. What is so terrible about a device having to meet additional standards with respect to interference?

Remember, all it takes is an aroused and organized group. We can make our ideas heard and heeded, if only we channel our energies together. Let's make sure that not another amateur receiver is plagued unnecessarily by extraneous noise, ever again. So, man the barricades! Storm the bastile! Oust the scoundrels!

Then the only thing we will have to worry about are plain, oldfashioned 40–over–9 unmodulated carriers jerks hollering "Hello, test. Hello, hello, test!" and pests who swish their vfo's back and forth over the whole band, while the transmitters are on lock key. That's all we'll have to bother us.

Some fun, eh, kid?

. . .K2AGZ ■

"Always be sure your obscene transmissions have redeeming social value."
Anon.

TVI from an Antenna Rotator

After several years of patient labor under tribander overload, my faithful AR-22 threw in the towel by breaking its bearings.

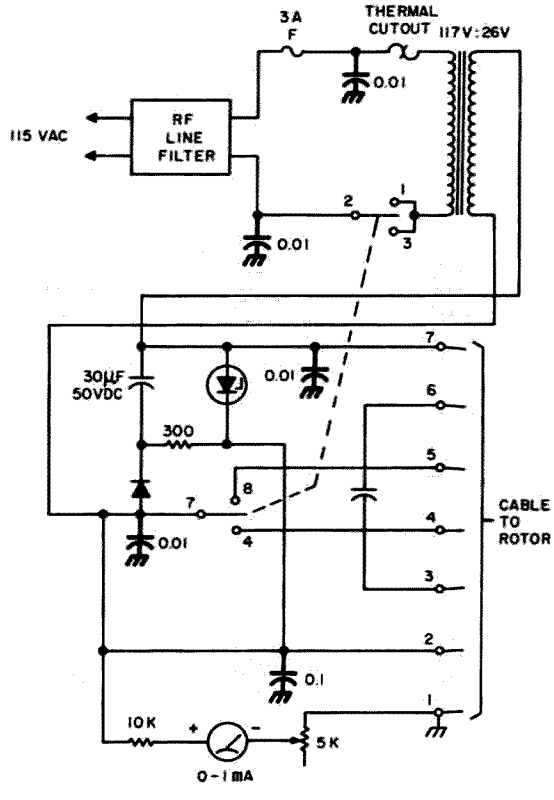
Since the need for upgrading was obvious, I purchased and installed a TR-44 rotator; and once more all was well in the beam spinning department.

However, during the course of a routine TVI check, a crosshatch which had not been there before, appeared on channel 6 at all power levels over 50 watts. Although located in a strong signal area, fringe area reception is simulated by using a filtered TV receiver, with indoor dipole, in the shack right under the beam. Normally, all channels are clean with 500W input on 20m.

Locating the source of TVI would sometimes try the patience of a saint, and this case was one of those times. The clue, which finally led to the detection of the culprit, was a small upscale movement, with keying, in the direction indicating meter on the TR-44 control box. This unit uses two diodes in the meter circuit – one to rectify the meter current, and a zener for meter voltage regulation. The long, multiwire cable from rotor to control box makes an excellent antenna, both to pick up the transmitter rf and to radiate the harmonics caused by diode rectification of this rf.

The rotor cable leads were bypassed to the chassis with five 0.01 μF 1 kW ceramic capacitors, as shown in the schematic. To gild the lily, a CF IF-54 rf line filter was installed in the ac line to the control box.

The meter now remained immovable with keying and the channel 6 crosshatch was gone. In this case, the interference was



Schematic of rotator with added capacitance shown in bold.

light and not of much consequence with a strong TV signal; but in a fringe area, it could have been troublesome in many respects.

Edwin Hill W3URE ■

Stephan Goldstein
146 Eighth Street
Providence RI 02906

The IC mitter

This transmitter was designed with the QRP fiend in mind. It uses inexpensive ($3.80) RCA type CA3000 integrated circuits. As crystal oscillators they will work to about 10 MHz, and if you're lucky you just might be able to use them at 20 meters. This transmitter will work on 160, 80, 40, and maybe 20. This contraption will put out AM or CW at the flick of a switch.

The schematic should be self-explanatory. If you build on Vector board I would recommend using sockets. As a matter of interest, the 2N3904 is for agc. Capacitor C1 should be chosen for good agc action — try 0.05 or 0.1 μF. Transformer T1 is a swamped 10 to 5 kΩ matching transformer. The values shown for it give a fairly good match. The C2-L1 network should resonate at the crystal frequency. Tap L1 wherever you get the best match. The AM-CW function is switched by a 3-pole double-throw wafer or toggle switch. For AM work, use a 50Ω mike (or something close).

These circuits are by no means completely original. Only partly. They were lifted from RCA publication ICAN5030. Also from File 121. Both are available from RCA for the asking. These papers provide much useful data on the CA3000.

Have fun!

Stephan Goldstein ■

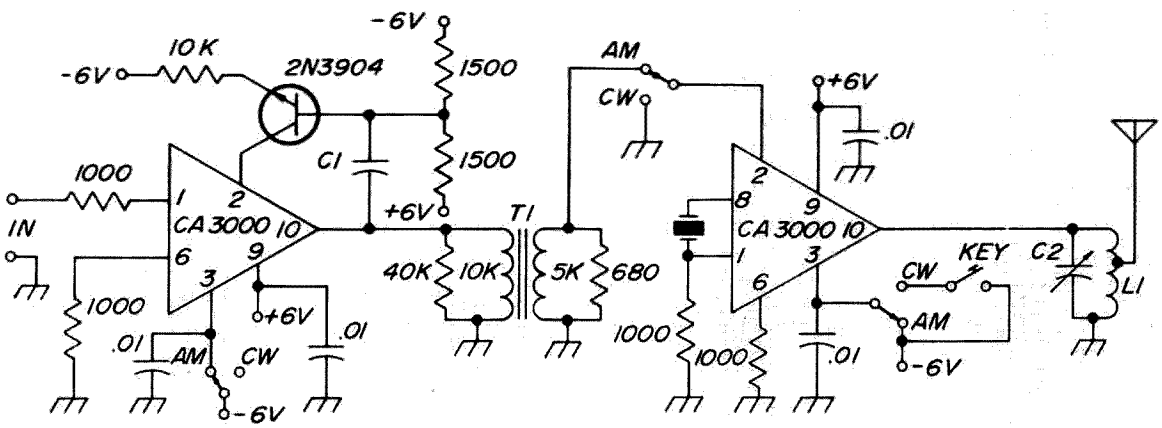


Fig. 1. See text for C1, C2, L1, T1. For CW you can also switch out the transistor if you want. Instead of keying the voltage, you could key the output. If you don't want agc, simply ground pin 2 of the first IC.

STUDY GUIDE GENERAL CLASS LICENSE

PART II

Now you see it, now you don't!

The General Class license examination covers many fine points of radio theory and practice – and many most basic points as well. Since the basics are necessary as a foundation upon which to build the fine points, we began this study course in our previous installment by accounting for voltage, current, resistance, magnetism, and the propagation of electromagnetic energy.

And since our space was, as always, limited, we did not get around to many of the basic points involved in ac circuits. That's our subject this time.

If you missed the previous installment, by all means obtain a copy before going further in this one. The two actually fuse into a single discussion, and we'll be making frequent reference to points covered before.

As always in these license study courses, we're working from the official FCC study list of "typical questions" – but we're not answering the Commission's own questions. Instead, we're expanding their range to cover a broader area, and examining that broad area in as great detail as we find necessary.

This time, the FCC questions we will cover are (numbers from the study list, as usual):

3. Define skin effect. How can this phenomenon be minimized?

33. What are the distinguishing features between series-tuned and parallel-tuned resonant circuits? How is the resonant frequency determined? Define the "Q" of a resonant circuit?

38. What is inductive reactance? Capacitive reactance? How is their value determined? How do like reactances combine in series? In parallel?

In addition, we will be winding up portions of questions 27, 35, and 36, which were begun last time around.

Because we know from our previous study what inductance, capacitance, volts, ohms, and amperes are, as well as series and parallel circuit connections, but have not yet met "reactance" or "resonant frequency," let's begin by asking "HOW DOES AC BEHAVE DIFFERENTLY FROM DC?" This will permit us to explore not only reactance and skin effect, but a more basic concept called impedance. From there, we will try to determine "What is resonance?" This discussion sets the stage for much of the later "practical work" on tuning of both receivers and transmitters. The "Q" factor is closely allied to "resonance," but is enough different that the question "What is Q" deserves its own discussion.

By the time we explore these three general questions, we should have a solid foundation in both ac and dc circuit theory, and be ready to move on to some advanced theory by next time around. Let's get started, then.

How Does AC Behave Differently From DC? We saw last time out that ac must be

measured differently from dc, because of the fact that ac is continually changing not only its intensity but its direction of current flow. We said at that time that voltage, current, and resistance were not so simply related in an ac circuit as they are with dc, as well, but we didn't dig in any deeper.

Let's do so now. Last time, we saw that resistors convert electrical energy to heat energy, that inductors impede changes in the flow of current, and that capacitors contain insulators which interrupt the steady flow of current.

All these effects are perfectly true of steady-state dc. With ac, however, there never exists a "steady state," because both the intensity and the direction of the current are always changing.

In a capacitor, for instance, a steady or dc potential will cause an accumulation of charge across the insulator or dielectric. If the potential is then increased, the charge which already exists will be of the same polarity. Since like poles repel each other, the charge already existing will tend to oppose the increase.

However, because of the "brute force" provided by the increased potential, electrons *will* move within the dielectric to establish a new state of charge and bring the capacitor's charge into balance with the applied voltage. Only after this movement has occurred will the full applied voltage exist across the insulation. The time involved is exceedingly small, but the net result is that a capacitor delays the voltage until current flow has stabilized.

If we apply ac rather than changing the voltage of applied dc, the same basic rules apply – except now, the current flow never stabilizes. It just keeps on changing, and the voltage never quite catches up to it. The net result is that the voltage cannot reach a peak value while current is flowing, and when current is at a peak of intensity no voltage exists across the capacitor.

In between these times, current will decrease from its peak as voltage increases from zero.

We express this by saying that the voltage "lags" behind the current.

Most usually, a simple statement that the voltage is lagging doesn't describe things accurately enough. We need to know just how far behind the current peak the voltage peak is located.

We could express the time in fractions of a second, but then we would also have to specify the frequency of the ac involved. To avoid this entanglement, we use the ac cycle itself as our time scale. Recall our simplified ac generator of last installment, which generated one full cycle of ac during one revolution of its shaft through 360 degrees of arc. We use this fact, and say that a full cycle of any ac sine wave occupies 360 degrees of a phase; that's our way of measuring time in ac circuits.

Since a full cycle is 360 degrees, let's arbitrarily set our zero-degree point on the instant when the current is crossing zero in a positive-going direction. The current's positive peak will then occur 1/4 cycle later, or 90 degrees. The next zero crossing will be another 1/4 cycle later, or at 180 degrees, and the negative peak will be still another 1/4 cycle after that, or at 270 degrees. At 360 degrees, we will complete the cycle and be back at the "zero" point of the next cycle.

To apply this to the voltage lag in a capacitor, let's see what happens to the voltage at these same four points in the current waveform.

When the current is at zero degrees, with the waveform crossing zero and going positive, the voltage is at its negative peak. This is the 270-degree point on the previous cycle, or 90 degrees behind the current.

When the current is at 90 degrees, at its positive peak, the voltage is just crossing zero going positive. This is the zero-degree mark of the current cycle, the same intensity which the current had 90 degrees earlier. Voltage is still 90 degrees behind current.

And, in fact, all the way through the cycle, the voltage is always 90 degrees behind the current – if a perfect capacitor is used, with no resistances anywhere in the circuit. This, of course, cannot be achieved in practice, but we can come astonishingly close.

Note that there's a very major difference here from what happened in the dc-circuit. With dc, the capacitor blocked all current flow. With ac, current flow continued right on through the capacitor, but the "lock step" relationship between current and voltage (which existed when the ac left its generator) has been disturbed, so that voltage now lags by 90 degrees.

Since we're assuming that there was no resistance anywhere in the circuit, no energy was turned into heat. However, with the current and the voltage waveforms out of step they are no longer capable of producing the same amount of power as they were before meeting the capacitor. The energy has undergone an apparent loss, but actually it's just out of time.

Because this apparent loss is due to a reaction brought about by the capacitor, we call it an effect of "reactance." Because the apparent loss is real enough to affect any circuit connected to it, we measure reactance in ohms just as we do resistance. The major difference between reactance and resistance, at this point of the game, is that resistance loses the energy permanently by turning it into heat, while reactance merely locks it up and makes it unavailable for us to use.

Going back now to the reason why voltage and current get out of step with a capacitor – the fact that the existing charge at any instant opposes any increase in charge – it shouldn't be extremely difficult to see that the more rapid the attempted increase, the more rapidly the change will occur. Similarly, the greater the capacitance involved, the more thinly spread will be the "existing charge" and the less it will be able to oppose the changes.

These two observations lead us to the point that the *greater* the frequency of the ac signal, and the *greater* the capacitance in question, the *smaller* will be the reactance..

Going in the other direction, as the frequency becomes ever lower it gets closer and closer to being dc, and since a capacitor is an open circuit for dc it must be a very high value of reactance for very low frequency ac. There's a formula for calculating reactance in ohms of any capacitor if you know its capacitance and the frequency of the ac signal involved, but we won't go into that just now. First, let's look at another form of reactance.

We have just seen that a capacitor introduces reactance into an ac circuit because its charge opposes any change in voltage across itself. We also know that an inductor opposes any change in current.

Because of this, the reactance of an inductor does not cause the voltage to lag behind the current as does that of a capacitor. Instead, with an inductor, the current lags behind the voltage.

The reasons are exactly parallel, however, to those which apply in the case of the capacitor. When the current flow is zero, there's no opposition (for a brief instant) and voltage intensity is at its peak. When current flow is at a peak, opposition is at a maximum and voltage hits zero. Just as with the capacitor, the inductor's reactance causes voltage peaks to coincide with zero-crossings, and the voltage zero-crossings to coincide with current peaks.

This means, automatically, that a 90-degree phase difference is introduced between the current and voltage waveforms by pure inductive reactance. Since it's the current which is delayed, this time the voltage is 90 degrees ahead of the current rather than 90 degrees behind.
delayed, this time the voltage is 90 degrees ahead of the current rather that 90 degrees behind.

Figure 1 illustrates both of these conditions, as well as the normal nonreactive relationship between voltage and current in a resistive ac circuit.

Current lag instead of voltage lag is not the only difference in a reactance between capacitors and inductors. They behave a bit differently with respect to inductance values and to frequency, also.

The more rapid the attempted change of current in the inductor, the more opposition is developed. Going the other way, the nearer the signal frequency gets to dc, the less effective the inductance is, since inductance has no effect at all on steady-state dc.

This means that while the reactance of a given capacitor decreases as frequency goes

up, the reactance of a given inductor goes up as frequency increases. The higher the frequency, the greater the reactance.

Similarly, the greater the inductance at any one frequency, the more the opposition. Thus the reactance increases as the inductance value climbs, while capacitive reactance decreases as capacitance is increased.

Since capacitive reactance and inductive reactance behave so differently in these three different areas, we must have some way of telling them apart in our equations and theories. The behavior is so different that they almost appear to be opposites. One causes current to lead; the other causes it to lag. One increases with frequency; the other decreases. One decreases as its corresponding unit increases; the other increases right along. This "opposite-ness" of characteristics is used to tell them apart in our symbols. We use the "+" and "-" signs of arithmetic to designate which kind of reactance we mean. If the reactance is capacitive, we tag it as "-"; if it's inductive, we call it "+."

This would indicate, and Fig. 1 would back us up on it, that we could use some of

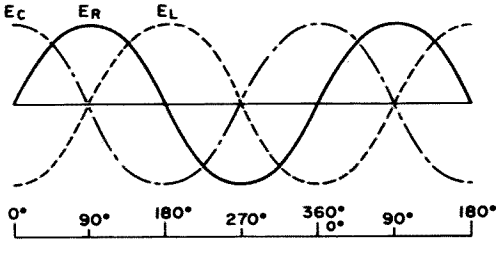


Fig. 1. Effects of capacitance, resistance, and inductance on phase relation between voltage and current are shown here. In all three cases, current phase is same as waveform E_R. Capacitance causes voltage phase to lag 90° behind voltage, which is same as causing voltage to lead current by 90°. Phase scale at bottom refers to phase of current waveform.

one kind of reactance to cancel out some of the other kind. As a matter of fact, we can do just that, and we're going to look at that process in great detail rather shortly. All we'll mention about it here, though, is that this gives us a "key" to "unlock" the power which was locked up in the ac signal by just one kind of reactance.

Now let's turn the tables just a bit, having met both kinds of reactance, and find out how to relate capacitor values in microfarads or inductances in ~~henries~~ to reactances in ohms.

It takes a bit of algebra, but nothing more complicated than Ohm's Law. Figure 2 shows the equations, in two forms. The

$$X_L = 2\pi fL$$

INDUCTIVE REACTANCE
(full formula, ohms, hertz, henries)

$$X_C = \frac{1}{2\pi fC}$$

CAPACITIVE REACTANCE
(full formula, ohms, hertz, farads)

$$X_L = 6.283fL \qquad X_C = \frac{159}{fC}$$

X	in ohms	X	in ohms
f	in megahertz	f	in kilohertz
L	in microhenrys	C	in microfarads

Fig. 2. Reactance equations. Versions at top are full basic formulas, with all quantities in "basic units." Those at bottom are practical versions. See text for details on their use.

first form of each equation is the full basic form, with all units in "standard" values such as hertz (cycles per second), farads, henrys, and ohms. The second form of each is the "practical" one for radio work, with units in more convenient form such as μF, kHz, μH, etc. The answers, however, still come out in ohms.

In case you're wondering how "pi" gets into the act in the first form of each equation, the answer gets a bit sticky. The most completely basic form of each equation is one of Maxwell's equations, which deal with rates of change and so involve concepts met in differential and integral calculus. To get from the "curl" of the electric and magnetic fields down to the "ohms" values which are of practical interest to us, it's necessary to go through

some partial differential equations. These, in turn, don't work with "degrees" or hertz, but instead with "radians," which are a different way of measuring angles that depends upon the ratio between the radius of a circle and the arc cut out of that circle by the angle involved. To convert from "radians per unit of time" into "hertz," we have to convert a measurement based on the circumference of a circle into one based on the number of revolutions. "Pi" is the factor which relates these, and that's why the reactance formulas both include "2 pi" as a factor.

"2 pi" as a factor.

In practice, of course, you don't have to worry about "pi" at all – because the magic figure "159" with the appropriate number of zeros fore or aft takes care of it, as well as doing the dirty work of converting from farads to picofarads, or from henrys to millihenrys.

The physical facts which these equations represent are those which we've already met in our introduction to reactance. A reactance in a circuit which contains no other elements will always have applied to it the maximum voltage which the source can provide. The reactive element's opposition to change – that is, to change in voltage in the case of a capacitor or to change in current in the case of an inductor – will act to limit the flow of current in the circuit to just that which is necessary to keep the circuit electrically balanced at all times.

We already know that a capacitor, for instance, offers less reactance to a high-frequency signal than to one of low frequency. The more rapid change of applied voltage brought about by the higher frequency signal requires a larger current flow to keep the circuit in balance or equilibrium. Similarly, for two capacitors of different capacitance but with the same frequency of applied ac, the larger capacitor will require more current to keep the charge at just the level which will satisfy the applied voltage.

The reactance equations simply express this relationship between voltage and current, in terms of capacitance (or inductance) and frequency.

Now that we are able to express a capacitor's or an inductor's value as "ohms of reactance" at any specific frequency, let's see how ohms of reactance combine with ohms of resistance. Cast an eye upon Fig. 3, which shows us a resistance-capacitance series circuit.

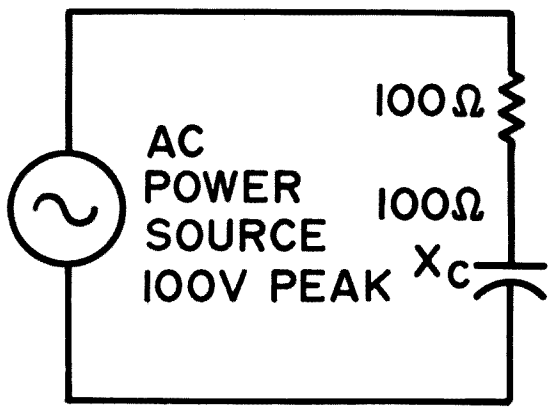


Fig. 3. Series L-C-R circuit illustrates how reactance and resistance combine. Effects of each influence action of total circuit, and result is neither purely resistive nor purely reactive. inductance behaves similarly.

In the explanation which follows, we'll assume that both the resistor and the capacitor are "perfect" or "ideal" components. That is, we'll act as if the resistor has no reactance at all, and the capacitor no resistance.

Since the circuit is a series circuit, by the definition we learned last time around, all of the circuit current must flow through each element. With dc applied, there will be no current after the initial transients die out, because the capacitor interrupts its path. But with ac, current will flow at all times, as the capacitor charge follows the applied voltage during each cycle.

Were the capacitor alone in the circuit, the voltage would be varying up to the full peak value provided by the power source, and the current would be that value defined by the capacitive reactance formula; with a 100-ohm reactance, it would be 1/100 the voltage value. In addition, the current waveform and the voltage wave-

form would be 90 degrees out of phase with each other.

Were the resistor alone in the circuit, the voltage would also be varying up to the full peak value provided by the power source, and the current would be that value defined by Ohm's Law; with a 100-ohm resistance, it would be 1/100 of the voltage value just as for the reactance we just looked at. In the resistor, however, current and voltage waveforms would be *in* phase with each other.

What happens when both are in the circuit? We know that any current which flows through one must flow through the other. Let's assume that our power source is putting out 100 volts peak (200 volts peak to peak, or 70.7 volts rms) and that both the resistance and the reactance have values of 100 ohms each (at 0 and –90 degree angles, respectively). That would indicate that 1 ampere peak would pass through either element alone. Let's see what happens when we assume that 1 ampere is passing through *both* in series.

We would, by Ohm's Law, find 100 volts peak, in phase with the current, across the resistor – and by similar reasoning, we would find 100 volts peak across the capacitor also, but this would be 90 degrees out of phase with the current and so would also be 90 degrees out of phase with the voltage across the resistor as well.

What happens when we have two voltages out of phase with each other in the same circuit? Figure 4 shows some waveforms which may help us to see the result. When one of the voltages is at its peak, the other is just crossing zero. When the second reaches peak, the first is crossing zero. For a part of the cycle, both have the same polarity, and for a part of the cycle, they have opposite polarity.

But we cannot have *two* voltages in one circuit, not across the outside terminals of the circuit. At any one measuring point, we can have only *one* observable voltage and *one* observable current. Since we can imagine each of our voltages separately, let's stretch our imaginations a bit more and see what happens when we merge them together into a single waveform.

At point A, voltage I is zero and voltage

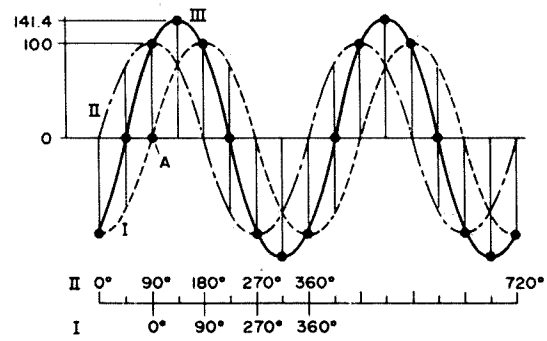


Fig. 4. Waveforms of voltages in circuit of Fig. 3 show what happens in combined circuit. Voltage I represents voltage across resistor, Voltage II is that across capacitor, and Voltage III is that across the total circuit. Voltage III is determined by adding together the values of I and II at each point along the time scale. Note that final voltage is halfway between original voltages in phase, and is greater than either alone but not twice as great as either.

II is at positive peak. The "merged" result (III) must be simply whatever value voltage II has right then. A little later, the two original voltages cross each other, one on the way up and the other coming down. Voltage III at this point must be equal to the sum of both, or twice as great as either.

In fact, all the way through the cycle voltage III must be equal to the sum of voltage I and voltage II. Where the two are of opposite polarity and tend to cancel out, read "difference" (most texts use the phrase "algebraic sum" to indicate that cancellation or reinforcement either can occur, depending on relative polarity).

And voila! Voltage III is still a sine wave, just like the two waveforms of which it is composed –but it's not in phase with either of them. It does, in fact, split the phase difference, so that it is 45 degrees out of phase with the current.

We still have one small insect in the unguent. Our original 100-ohm values were based on a 100-volt-peak source and 1 amp current. Voltage III has a peak value considerably greater than 100 volts. It works out to be 141.4 volts, if you care to measure it (and if our illustrator has drawn his sine-wave curves accurately).

However, in a series circuit, the total voltage across the outside terminals where we're observing voltage III must be equal

to that provided by the power source. That means that we can't have 141.4 volts here; we are limited to 100 volts for the total.

We compensate for this by assuming a reduction in current, and this is only reasonable since whatever the resistor turns into heat isn't going to be available to the capacitor. To cut the total voltage from 141.4 to 100 we can merely divide it by 1.414. This indicates that we should divide our current figures by 1.414 also, so that we have only 0.707 ampere peak instead of 1 amp.

With 0.707 ampere through the resistor, the voltage across it becomes 70.7 volts peak. That same 0.707 ampere through the capacitor sustains a 70.7-volt peak potential across it, and if both voltage I and voltage II are 70.7 volts peak, then their combination into voltage III will produce 100 volts peak, and everything balances properly.

We have seen, through some illustrations and a lot of specific numbers, that 100 ohms of capacitive reactance combine with 100 ohms of resistance to produce a result different from either reactance or resistance. What is this result called?

Its name is "impedance," and like resistance and reactance, it is measured in ohms. The name "impedance" comes about because impedance is the combination of resistance and reactance, both of which impede the transfer of electrical energy.

How many ohms of impedance does our sample circuit have? We could take a stab at figuring it out by applying Ohm's Law to the figures we finally worked out of 100 volts and 0.707 amperes; this would give us a figure of 141.4 ohms for "R" – but it's impedance rather than resistance we're figuring, and "R" is the abbreviation for resistance. Impedance is always abbreviated as "Z," while reactance is "X" with a C or L subscript to identify it as capacitive or inductive.

That stab is exactly accurate, because Ohm's Law does work for ac circuits just as well as for dc if all the "R" factors are replaced by Zs. However, there are simpler ways of expressing impedance than by having to figure out all the currents and voltage drops in a circuit.

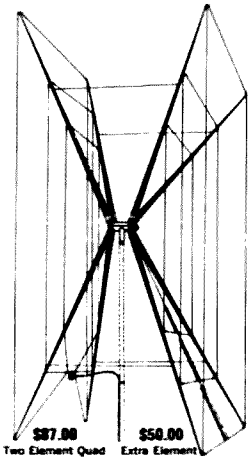
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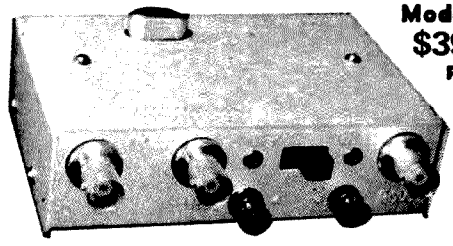
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One of the simplest ways to express impedance, and one which is in wide use by engineers and sufficiently general use in the ham field to make it necessary that you know it, is not to combine the R and X at all into a single figure, but to express impedance as a sum "R ± jX." The sign is plus if X is inductive, and minus if X is capacitive (that is, the sign in the sum follows the sign of the reactance). This is known as the "complex" expression of impedance, because it's the form used in mathematics to express "complex numbers," but it's actually less complex than the arithmetic you have to go through to combine the R and the X into a single value of Z.

The impedance of our sample circuit, expressed this way, would be "100 – j100" ohms. The "j" is an indicator telling us that the number it accompanies is a reactance rather than a resistance.

For many purposes, this is the clearest way to put it. One of the major ham applications of "complex" impedance values is in rating feedpoint impedance of antennas and transmission lines. The object in this case is to get the "j" value to zero, which we can do by adding reactance of the opposite sign, and the "R ±jX" way of expressing the value tells us directly how much and what kind of tuning reactance is necessary.

The other way of expressing impedance reduces the sum to a single number, such as the 141.4 ohms we came up with a few paragraphs back. To be accurate about it, such a number must always be accompanied by its phase angle, so that the

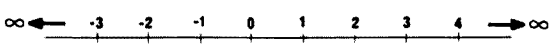


Fig. 5. This "number line" is basis of graphical method of determining impedance values. It provides conversion from picture to actual values.

impedance of our sample circuit is actually 141.4∠-45° ohms. To show why the angle is necessary, and to show how to figure the number and angle, we're going to have to put it in some more pictures.

If you've been exposed to "the new math" either as a student or as a sidelines observer, you have probably met a "number line" already. If not, one awaits in Fig. 5. This is just a line divided into regular spaces, like a ruler, with zero in its middle. Each space to the right of the zero point is one more positive number, and each to the left is a negative number, so that the spaces run -4, -3, -2, -1, 0, 1, 2, 3, 4 . . . The idea is that this "number line" offers a picture of the way we count things, and we can use a number line to illustrate anything that is countable, which includes the number of ohms of impedance, resistance, or reactance in a circuit.

This "number line" idea is, in fact, the basis of all the graphs we use to show how quantities vary with respect to each other, because the two axes of any normal graph are simply crossed number lines.

We can cross two number lines as shown in Fig. 6, crossing them at their zero points and placing them at right angles to each other, to show how resistance and reac-

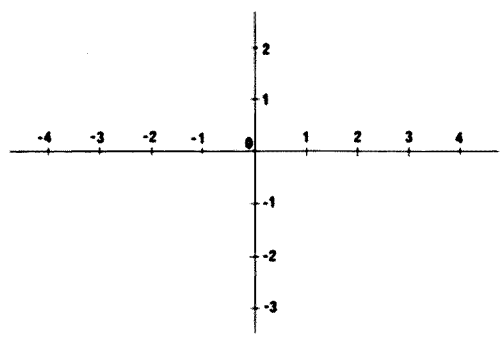


Fig. 6. Crossing two number lines at right angles gives us a "number plane" on which we may draw a graph. The two number lines provide scales for the graph.

tance combine. It doesn't really show "how," but as we shall see everything fits properly, so the idea is workable (the real "how" is the combining of voltages which we've already suffered through back in Figs. 3 and 4.) We shall call the horizontal scale the resistance or "R" scale and the vertical scale the reactance or "X" scale. "Negative resistance" is hard to find, so most of the time we'll use only the right-hand half of the resistance scale, but both halves of the reactance scale come

into play because of our convention that capacitive reactance is negative while inductive reactance is positive.

If we plot our 100 ohms of resistance from Fig. 3 and the -100 ohms of capacitive reactance on the graph of Fig. 6, we come out as shown in Fig. 7 with a pair of

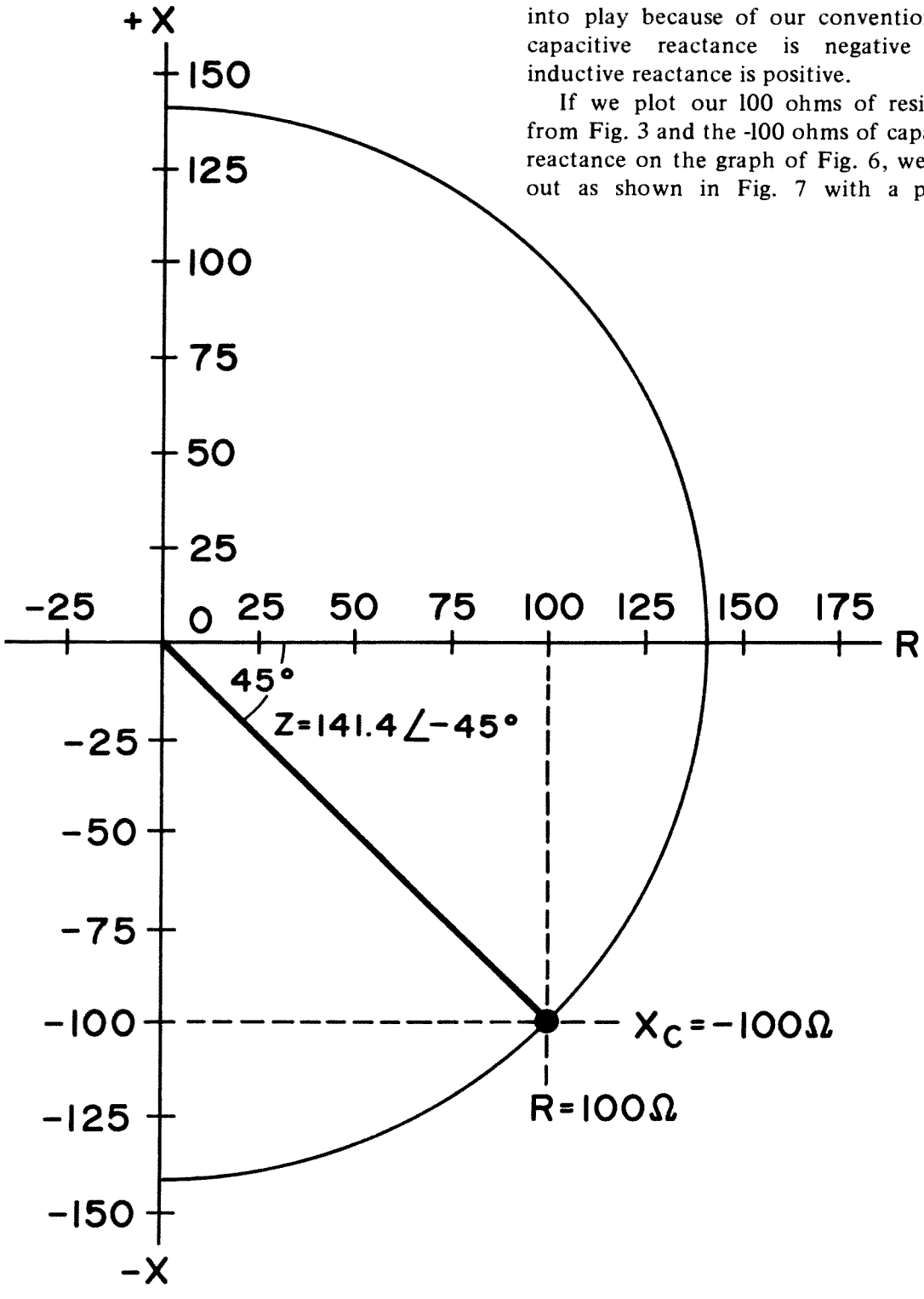


Fig. 7. Combination of 100 ohms resistance (horizontal scale) and 100 ohms capacitive reactance (vertical scale) gives us impedance of 141.4 ohms at phase angle of -45°. Text explains in detail how number plane is used to determine these values. Only right half of plane is needed because the left half represents "negative resistance" values, which are seldom encountered in practice.

dashed lines. The point at which these lines meet represents the combination of 100 ohms resistance and -100 ohms reactance.

We can now draw a straight line from this point back to the common zero point of both lines, and this single straight line represents the combined impedance of the circuit.

If we measure it, we will find (assuming that out illustrator remains accurate in his work) that it comes out to the same 141.4 ohms that we found by arithmetic before, and that it is at a -45 degree angle from the resistance scale.

These are the same figures we worked out previously, and so prove that in this case at least the graphical solution is right. It will be in all cases, because the graph is an exact chart for this particular problem.

Rather than drawing the graph and measuring the impedance line and angle, the normal practice is to calculate them from the relationships of the right triangle. The impedance line is the hypotenuse of the triangle, while the resistance and the reactance are its legs, so that Z^2 must equal $R^2 + X^2$. The trig functions of angles save us the need of working out all of this, because the phase angle can be determined by using the ratio X/R and finding the angle which has this ratio for its tangent. This angle is the phase angle of the impedance; the cosine of this angle is equal to the ratio R/Z, while the sine is equal to the ratio X/Z, so that with a table of trig functions we can get both Z and phase angle if we know R and X, or can get R and X if we know Z and phase angle. Figure 8 shows all the appropriate equations for converting from one way of expressing impedance to the other.

Before we leave Fig. 7, though, we should pause to see why it's so important to always include the phase angle when we're talking about impedance if we don't use the "complex " method.

We found, using Fig. 7, that the impedance of our sample circuit was 141.4 ohms of pure resistance, 141.4 ohms or pure reactance of either sign, or *any* combination of R and X which would bring us to a point lying on the circle in Fig. 7, because every point on this circle is 141.4 ohms away from the zero point.

To make sure that the *one* point representing the combination "100–j100" ohms is understood, we must add the $<-45°$ phase angle information. This angle defines a line which starts at the zero point and goes on indefinitely at a 45-degree angle. However, the line and the 141.4-ohm circle can cross each other only once, at a single point, and so the two together make our impedance specification exact.

Now that we're on reasonably solid ground with resistance, reactance, and impedance, we can turn our attention to the question of how like reactances combine in series circuits. So long as it's the same kind of reactance, and assuming (it's important to note that this assumption can hardly ever be achieved in practice) that each reactance is completely independent of every other one in the circuit, they will simply add together like resistors would. What they will add, however, is their *reactance* rather than their capacitance or their inductance. Two capacitors, each having 100 ohms reactance by itself, would produce 200 ohms reactance when connected in series. A quick look at the reactance equations will show that this is the same as one capacitor of *half* the capacitance.

Most textbooks have a string of equations for you to memorize in this respect, in order to calculate the total effective capacitance of any number of capacitors connected in series. We're showing you the equations as Fig. 9, but you don't really need them. All you need do is figure out the effective reactance of each capacitor at

$|Z| = \sqrt{R^2 + X^2}$ $\qquad$ $R = |Z| \cos\theta$

$\theta = \text{ARCTAN}\left(\frac{X}{R}\right)$ $\qquad$ $X = j|Z| \sin\theta$

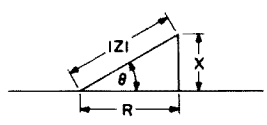
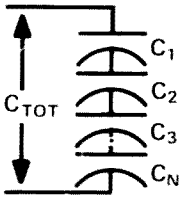


Fig. 8. These are the four equations which are used to convert from "polar plot" impedance expression (Z ohms at phase angle $\emptyset$) to "rectangular plot" or "complex" expression (R + jX). Vertical bars on either side of "Z" in equations mean "absolute value without regard to sign." Sketch identifies variables with respect to Fig. 7. "Arctan" means "the angle whose tangent is."

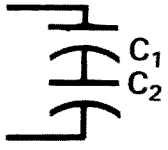
some arbitrary frequency such as 159 kHz (which will cancel out all conversion factors if you use it), then total up all the reactances and convert the resulting total reactance back to a single value of capacitance by reversing the conversion formula.

The same trick works with inductors – but if you use a frequency of 1/159 MHz for them, you'll find that it boils down to simply adding up inductances the same as for resistors.

The same trick works for parallel circuits, if we use a couple of other characteristics which are related to reactance and resistance but are not the same thing. These are "susceptance," which is the reciprocal of reactance, and "conductance," which is the reciprocal of resistance. Susceptance is abbreviated B, and



$$C_{TOT} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\cdots+\frac{1}{C_N}}$$



$$C_{TOT} = \frac{C_1 \times C_2}{C_1 + C_2}$$

Fig. 9. General equation for determining effective value of several capacitors connected in series is shown at top. If just two capacitors are involved, simplified equation at bottom may be used. Since both these amount to an addition of susceptances (see text) and conversion back to reactance, they also apply to parallel resistors and to parallel inductances, by substituting "R" or "L" for "C" in the appropriate formula.

conductance as G. Impedance, too, has a reciprocal – "admittance," abbreviated Y. In parallel circuits, just total up admittances; in series circuits, total impedances.

Since like reactances in series behave just like resistors in series so far as total effective value is concerned, and since Ohm's Law holds for ac as well as dc when

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we substitute "Z" for "R" in the equations, it's only natural to expect that ac voltage across a series string of like reactances would divide just as dc voltages do across a string of resistors.

The expectation is correct. In similar fashion, the current through parallel reactances of like sign will divide just as dc divides among parallel resistors.

All of this follows quite naturally from a conclusion which you may have already reached but which we have waited until now to point out: Both "resistance" and "reactance" can be thought of as being merely special types of "impedance," because any pure resistance can be expressed as an impedance of 0 degrees phase angle or "R± j0," while any pure reactance can also be expressed as an impedance with ±90 degrees phase angle (or "0±jX").

This way of looking at "resistance" and "reactance" as being merely forms of "impedance" lets us consider the ohm as always being a measure of "impedance," in all cases. The engineer's definition of both impedance and ohms is based on this; an "ohm" is the ratio of voltage to current in the circuit, and any quantity measured in "ohms" is an "impedance."

From these definitions, we get such factors as the plate resistance of a vacuum tube, the input and output impedances of amplifier circuits, and many more. We'll go into them in more detail later, when we need to. Right now, we're still working with the basics and building our foundations.

What about such things as "rf resistance" and "skin effect?" Both of these are effects due to impedance, and particularly to inductive reactance.

In the next installment, these areas will be covered in depth. Since they are associated inseparably with the theory covered here, the next chapter will be a continuation of "Part II" in the series, and the figure numbers will continue in the sequence already established.

To prepare yourself for the balance of the discussion, do a little extra studying of the Part I text involving flux lines and current flow. . . .Staff ■

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NEVER SAY DIE *(cont. from page 9)*
constructive criticism will be found in QST, which puts the ball in our court.

Lobbying in Washington

If we don't have the support of our own country, how can we expect to get the support of others? We need the unqualified support of the U.S. delegation when the next ITU conference comes up. The U.S. delegation is by far the most important one at the ITU for two basic reasons. . .first of all because the U.S. has so many subtle means for coercing other countries into going along with its policies. . .and secondly because the U.S. team dwarfs all the others and thus has representation in force on every possible committee. Smaller countries have to choose which committees they will serve on, and just shrug about those they can't manage. The U.S. is on all of them and thus has a finger in every pie. This gives the U.S. quite an advantage over all of the other countries.

Do we have our government behind amateur radio 100%? No, we don't. Our government, like all others, bends in the direction of the pressures being brought to bear. The one radio service that is conspicuous by its total absence in the past has been amateur radio. Virtually our only friend at court has been Senator Goldwater, and he has done fabulously for us. But it is really unreasonable to expect Barry to neglect his responsibilities to Arizona and keep up the pressure for amateur radio that is needed to counter the constant pressures from all of the other radio services.

I wonder if you have any idea of what is involved in lobbying for amateur radio? This means getting in to see senators and representatives to discuss with them the importance of amateur radio to their state and to them. It means getting amateur radio achievements into the congressional record at every opportunity. Now, as you probably know, you don't just walk up to the senate office building and sit down to talk with a senator. He has a schedule that is filled sometimes for weeks ahead and you have to work your way into his schedule at his convenience, not yours. It also means a lot of waiting, because just before your scheduled meeting the senator will be called to the floor for an important debate or vote and you have to wait until he gets back or else get on the list for another appointment next week or even next month.

You have to do a lot of your work by mail, too. The senators will have questions that you will have to research for them. Most of them get letters from ham constituents every now and then and they want some way to get the right answers for these questions as quickly and simply as possible. You can help, but it means time and work. . .and letters. . .and phone calls.

All this is groundwork. Then suddenly along comes some legislation having to do with amateur radio. At this time you need every contact and friend you have made to get the bill into perspective and to round up the votes you need to get it through, stop it, or amend it. You have to know who to contact at the FCC to get the right answers. . .at State. . .etc.

Or perhaps an FCC docket comes up that is important. You can bet that pressure from congress will have a measurable effect on the outcome.

How many of you can tell me who this important man is that we have in Washington lobbying for amateur radio? Is there an ARRL representative working for us there? You know the answer is no, there is no representative of the ARRL lobbying for us in Washington. There is one man in the U.S. that is registered to lobby for amateur radio and only one. . . ***me!***

I make the two-hour drive to Boston, the hour flight to Washington, and get in to see everyone I can during the short times that I can get away from 73 and Radio Today, but I want you to know that you are leaning on a mighty weak crutch when you depend entirely on me to beat the drum for amateur radio. I would much rather spend my time up here in cool New Hampshire than down in sweltering Washington . . .and my wife feels the same way about it since she has to mind the store while I'm away. Please ask your ARRL director why our hobby can't do any better than me for a representative of amateur radio.

More JY1

Several amateurs, after reading my report on Jordan, called me long distance to thank me personally for what they considered the most important achievement of my trip. . .a vote for amateur radio at the ITU. Hundreds have called me on the air to thank me for giving them a new country. Letters of compliment continue to come in from all over the country (nothing heard from ARRL yet), plus one sour note from Dave Mann K2AGZ.

Dave writes that "All my Zionist friends have been giving me the business," because the JY article was "pro-Jordan" at a time "when shots fired in Jordan are killing kids in Israeli school buses."

Zionists, above all else, should not be so completely out of touch with what is really going on over there. I do not believe that the Jordanian army is in any way involved with the fedayeen commando attacks. With some 25,000 fedayeen overrunning their country, the Jordanians are virtually helpless to seriously curb these Palestinian refugees. The money and supplies for this guerilla army are provided primarily by Libya and Saudi Arabia, with none coming from Jordan, as I understand the situation. The fedayeen commandos are paid almost four times the money that the Jordanian army gets, by the way. And they are better supplied.

Where does all the money come from for the commandos? The path, as it looks to me, is first from your pocket to your local gas station or fuel oil dealer. From there it goes to the big oil companies. They send it to the Arab oil coun-

tries, who in turn send it to the commandos. I might point out right here that Jordan has no oil whatever.

Perhaps the serious Zionist would do best to consider an electric car, or at least one of the foreign cars that use about one third the gasoline that his Cadillac does.

Those of you who have been following the political situation in the Mideast know that the moderates in Israel and the Arab moderates are almost in complete agreement on solutions to the problems of Palestine. Unfortunately, the extremists on both sides are preventing the moderates from getting together and accomplishing anything. I don't think that anyone would characterize King Hussein as other than a moderate.

Indeed, early in June the gulf between the Jordan government and the commandos resulted in bloody battles, with hundreds killed in Amman and King Hussein almost assassinated. The announcement of more arms for Israel from the U.S. triggered off this fight, a reaction to the commando feeling that Hussein was too friendly to the U.S.

With Israel getting more U.S. arms, and with none being sold to Jordan, the U.S. may finally force King Hussein to make a deal with Russia, though he has obviously been extremely reluctant to do this thus far.

Bum Rap

Reports are rampant that K2IXP (Larry) will be active from the Laccadives (VU4), but on the other hand many seasoned DX ops remember that VU2NR (Raju), the president of the Radio Society of India has been trying for several years to get permission to go there and without success. I may be doing Larry an injustice, but I was a bit annoyed to get the report that he had been invited to Jordan by King Hussein, only to be attacked as he tried to enter the country. I was there and talked with Larry when he was in Amman and I know what happened. The incident was unfortunate, undoubtedly, but it was nothing like that.

When I contacted Larry before my trip to Jordan he was operating as K2IXP/4X4 and mentioned that he and his wife might come over to Jordan while I was there. When he arrived in Jordan he got into trouble almost immediately. I was in the middle of my conferences with the government heads while setting up the Royal Jordanian Amateur Radio Society and couldn't get away to see him. By the next day he had left the country.

Larry explained on the phone that he and his wife had been in downtown Amman looking around when one of the commandos attacked him. Other commandos came immediately to his rescue and rushed him to the hospital for repairs. After a good deal of checking on this I found some confusion about whether the argument started over his wife getting pinched (she was wearing a short miniskirt, which is bad taste in Amman) or his taking pictures of some commandos. At any rate the commandos were most apologetic about the matter and offered to escort them anywhere they would like to go in Jordan.

When I mentioned the incident to His Majesty that evening he said that he had heard nothing of Larry's coming and offered his sincere regret for the trouble and asked his secretary to check the next morning and see what could be done to help. Pat checked and found that Larry and his wife had already left for Syria.

The Opinions Expressed, etc.

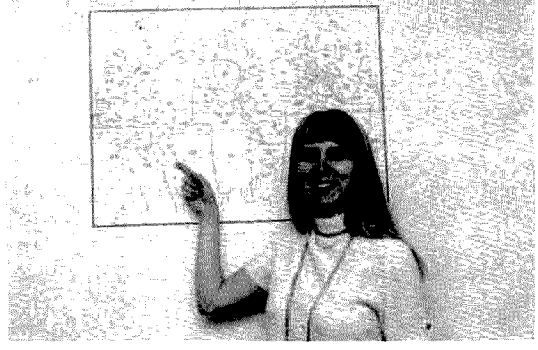
Unlike any other ham magazine that I can think of at the moment, the opinions expressed in articles, letters, and editorials, other than by the publisher, in 73 do not necessarily (or even usually) coincide with those of the publisher. Only 73, of all the magazines, recognizes the importance of an outlet for more than one person to make a fool of himself.

How About a Sked?

Since I would like to get info of interest for our news pages, DX news, and stuff like that, perhaps it would expedite matters if I could get on the air on a specific frequency at a specific time fairly regularly. Let's give it a try and see how it works.

On nights when Lin doesn't yank me off to the movie or I'm not out of town at a hamfest or something, I'll listen on 14,300 at 0200 GMT for any calls. . . . Wayne ■

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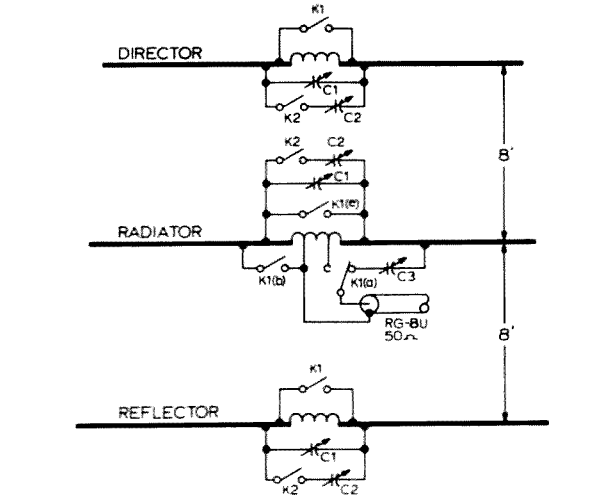
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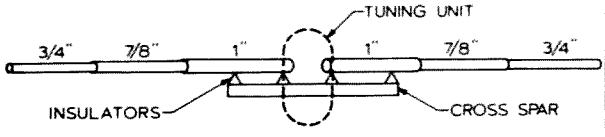
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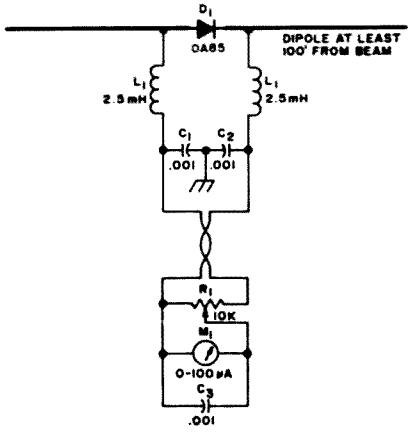
73 left out some important sketches from E.R. Shepherd's June 1970 article entitled "The 663 Beam." The top sketch shows element networks and spacing. The second sketch shows details of element construction. The bottom shows the setup of the remote dipole.

Sorry about that.

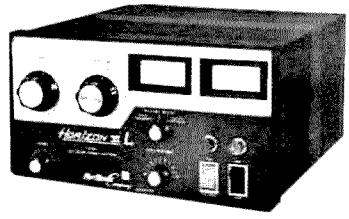
. . .Ed.





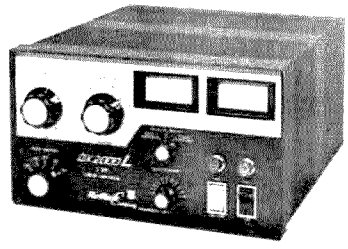


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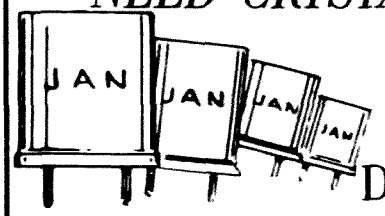
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Article Nonpayment

73 has received a number of letters from reader-authors who complain that they are not always paid for their efforts. Many of those who write ask that their names and letters be held in confidence (understandably). Others are quite willing to be quoted. Here are a couple of letters in the latter category. These are representative letters of complaint. For obvious reasons, 73 has not been able to verify the claims.

. . .Ed.

I wrote an article for CQ two years ago and they still haven't paid me. You can find my article in CQ, Nov. '68. The amount is over $150. The attorney general informs me that he can do nothing about it, so feel free to use my name and article and date as you see fit.

Neil Iverson W7PVF
2640 S. 133
Seattle WA

You might contact postal authorities and see if advertising author remuneration without following through might constitute mail fraud.

Could 73 suggest an attorney who has had experience handling cases against CQ? I am interested in bringing "breach of contract" proceedings against Cowan over a booklet manuscript of mine he contracted to publish but won't get on with and refuses to return my material.

John Schultz W2EEY
Arabella St. 18
8 Munich 81, Germany

Wayne is answering your letter personally.

JY1

Hooray for JY1. Now stop playing favorites and get thee over to 4X4-land pronto. Lox and bagels to you.

Anonymous
Clifton NJ

Wayne had complete control of a difficult (DX) situation. It was a real pleasure to hear him. . .in his quiet and forceful way. . .chastise inconsiderate breakers from other areas who kept calling when he specifically called for *sixes*. . .

Steve Cerwin K6OJO
4 Longfellow Rd
Mill Valley CA

The cover pix and article about Hussein (June 1970) is number one! (That wasted space given for article introductory pages is number ten thou.)

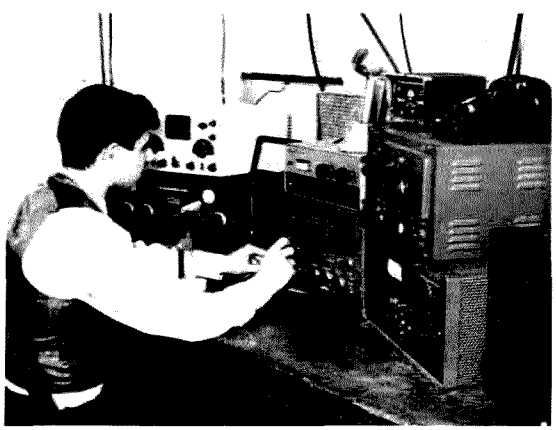
Stan Pugh WA7KSC
2521 N. Proctor
Tacoma WA

I'm quite sure that Wayne did a masterful job in getting the Jordanians on the air by getting them started with two classes of license – also

(cont. on page 88)

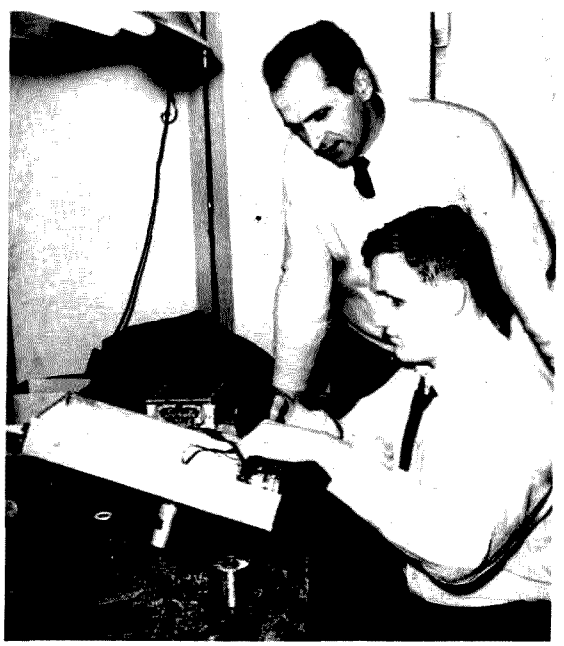
Club for Blind Amateurs:
K1TPX Perkins Radio Club

The hobby of amateur radio has appealed to some students of Perkins School for the Blind in Watertown, Mass., so much so that they have formed a radio club. There are eighteen members in the club with president George Henault presiding. He is shown here operating the club station, consisting of a Central Electronics 200V with the matching 600L linear. This equipment lends itself well to operation by the students for there is no loading involved. The receiver is a Hallicrafters SX-101A. The antenna is a Mosley TA-33 beam on a 75 ft Tristao crank-up tilt-over tower. Mr. Paul Bauguss, WA1CAQ, the faculty adviser, is responsible for much of this fine gear.





Dick Gonyea, an electrical engineering student at Northeastern University volunteers three hours a week to help the younger members achieve their novice licenses. Glenn Grimes and Paul Burkhardt are studying Braille schematic diagrams under Dick's watchful eye.



Ted Filteau, a previous president, is learning to build a transmitter with the help of Jim Dossett, KITIH. Jim makes available his Thursday evenings in order to help the members at Perkins. The simple CW transmitter that Ted is building as a project will be operational when finished.

The Perkins' Radio Club KITPX has been in existence for about seven years and shows no sign of diminishing.

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(cont. from page 84)

for (opening the door for) any ham visitors that may be planning on visiting Jordan in the future. I commend 73 for having a very good cover picture of King Hussein.

Ken Mahoney K6OPG
455 41st Ave.
San Francisco CA

Enjoyed reading about King Hussein. I regret the problems he's had lately. Hope he comes out on top of it all.

Stewart MacKenzie
16182 Ballad Lane
Huntington Bch CA

Thanks to Wayne for what he did for Hussein and for all of us. In impact, it dwarfs another $50 million in lend-lease or whatever the dole is called these days. How about sending the King a decent tribander and rotator so he can hear us a bit better? Could be done on a contribution basis so that it is a personal, men-to-man gift from American hams. (It would) keep out commercial interests and show the man that individuals in the U.S. admire him and can see past politics and apparent government favoritism.

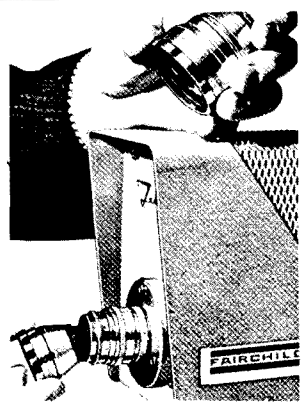
Ned Raub W1RAN
207 Thames St.
New London CT

My appreciation for Wayne's untiring effort in the area of bringing about a better understanding between the U.S. and other countries. With this kind of leadership in our amateur radio ranks, we find a "challenge" and "incentive" to follow up with each opportunity to bring about deeper understanding and brotherhood. It is with renewed interest that I now operate my station. It is good for you to know that you have much support in your efforts to strengthen ham radio at home and abroad. The amateur ranks need what 73 is giving!

Larry Vines WA4WIA
1645 Dobbs Ln
Birmingham AL

Editorials

The editorial by K6MVH in the June issue of 73 in which he says, "Hancock and Adams were the Seales and Hoffman of their time," ripped it with me. This kind of crap is out of place in a technical magazine and I refuse to pay my money for the political philosophy of Mr. Sessions or



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Mr. Mann. Please cancel my subscription and refund me the balance due.

Charles V. Thomas K5EDI
327 Mason
Hot Springs AR

Hancock and Adams were anti-government. They were members of a very vocal minority, and were, only after much persuasive strategy, able to swing public opinion their way. The govenor of Massachusetts ordered their arrest for insurrection, treasonous acts, etc. The chief differences (as far as I can tell) between Hoffman and Hancock are the tactics and motivations. Seale and Hoffman could hardly be considered as heroes.

. . .Ken

This expresses my appreciation for continuing excellent coverage of the significant happenings and affairs in Amateur Radio. 73's objective and "involved" editorializing is in refreshing contrast to the trite, trivial, and paternalistic editorial exhortations of QST.

J.W. Sandbert, K6HE
1138 E. Rustic Road
Escondido CA

Mixed Metaphors

Dear Editors: Been reading 73's comments on ARRL. Now I have no howdy do for either of you. But I think you are looking for someone to fight a war for you. If you have all the answers, why in Hell don't you grab the bull by the horns and take over. You remind me of a young snotnose – along with the ARRL! Grow up. Kid, if you can't face the music, get out of the competition game. Soon as I find the QTH for "past life" extension am going to subscribe for life just to see how long you take growing up.

Mr. L. Venzor WA9PAH
3011 South Ave.
Chicago IL

73's Study Guide

I am pleased to renew my subscription to 73 for another three years. 73 has shown a vast improvement over the last several years and is making a great contribution to amateur radio with the license study course you so wisely published. I find that other magazines are either too technical or have just deteriorated. I am not renewing my subscriptions to these other magazines when they run out. I am now a life member of ARRL and will continue to support it. Keep up the good work.

Alfred Smith WA2TAQ
11 Irving Place
Lynbrook NY

Your theory on how to pass exams should be put in a book form. It's the best thorough explantion I've ever seen. Your SSB article cleared up a lot for me.

J. Brousek
4704 Bragdon
Cleveland OH

The study courses are available from 73 bookshop – $3 postpaid. Specify Advanced or Extra.

One of the fellows in my office showed me the 73 Advanced Class license handbook. I'm much impressed. As an ex-military electronics instructor I'd judge it to be as good a discussion

RG 196 AU 50 ohm teflon coaxial cable. Outside diameter .080" RF loss .29 db per foot at 400 Mhz. Silver plated shielding and conductor. Used for internal chassis wiring, antenne coupling, RF coupling between stages, etc. Random lengths from 35 foot to 150 foot. Colors: black, red, brown, blue, grey, orange. Regular price- 23¢ per foot. Our price 5¢ per foot $3.00 per 100 ft.
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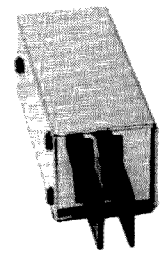
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of radio principles and practices as I've seen. It certainly doesn't bear much resemblance to that tortured language in the ARRL Handbook or my college textbooks.

David Halliburton W9EQG
10809 Old Coach Road
Potomac MD

I am a newcomer to ham radio and I would like to thank you for your *Advance Class study guide.*. I became interested in radio years ago but did nothing about it. But in November 1969 I purchased two code practice tapes (Codemaster) and your study guide. As a result of my practice and study, I was able to breeze through the Advanced ham license test in February.

Edward H. Stiles WA6RDB
6529 Hillgrove Dr.
San Diego CA

Thank you very much for providing the Advanced & Extra Class study guide. I failed the Advanced the first time, but after reading your study guides I passed them both! I operated CW 99% and could not bear to lose the best parts of the bands. Otherwise I doubt if I would ever have sought the Extra Class. Thanks again.

Ken WA9OQE

ZIP Codes

Of late we are getting a lot of mail, postcards, etc., in which some of our inquirers who write in for catalogs, as a result of our ad in your publication, are not putting on their ZIP code. They are not writing legibly, some of the handwriting we cannot decipher.

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Jimmy J. Mistry
Bella Vista
Bandra Bombay 50,
India

With reference to several publications observed in the 73 magazine about accommodation for visiting hams, I wish to let it be known that visiting hams to Trinidad and Tobago are welcome at our QTH with such activities as: Island wide tour, DXing with rig in shack, meeting the local hams, living accommodations with meals only if necessary, help on current project in shack accepted but optional.

Victor L. Steele
96 Charlotte Street,
Port-Of-Spain,
Trinidad, W Indies

Powder Puffs

I read with interest the article by Dave Middelton W7ZC "Ground Support for the Powder Puff Derby," June '70. This issue is being called to the attention of all our membership so they can enjoy this feature.

Penn-Jersey YL Club will be handling the terminus portion of the 1970 Derby at the 3M airport. The national chairman is one of our members and has appointed me as radio chairman for the terminus. This article gives us a complete scope of what we may expect during our coverage in this public service as a club. I am most anxious to meet some of the race officials, especially because our daughter is learning to fly and is also a licensed amateur. We hope to see future articles such as the one by W7ZC.

Rose Ellen Bills WA2FGS
17 Craig Place
Pennsville NJ

Hobby License

Your proposal for a no-code/no-theory "Hobby" license hit me like an invigorating blast of fresh New England air on a frosty Autumn morn. You are to be commended for this imaginative, yet practical, remedy to a hypocritical situation which has reached the bounds of absurdity. This proposal merits the wholehearted support of hams and CB'ers, League and non-Leaguers, alike. Even though the hour is late, it still just might be possible under this proposal to weld the ham fraternity back together again.

73 Magazine is certainly demonstrating its positive leadership in the field of amateur radio. The strong editorial positions are doing much to close the "communications gap" that our hobby has been plagued with lately. It's comforting to know that someone is more concerned with hams than simply "hamstringing" them . . .

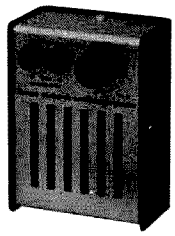
Ed Collins WN6ABG
161 Arlington Ave.
Kensington CA

QSL for Profit?

I must disagree and take umbrage with Mr. Shawsmith and his statements in his article "QSLing, Ham Radio's Own Con Game!" I have been a QSL manager for several years and sincerely believe that he has a nerve making such statements and you have the same for publishing them.

I do not intend to make a detailed legal reply to the unfounded allegations set forth therein. However, I can say that if it were not for the QSL manager, a great deal of the DXing as it is today just would not be. The only fault that can be found with the system is that there is such a demand among awards for QSLs themselves

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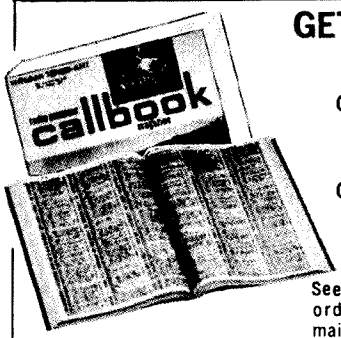
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which makes it essential that they be possessed.

There is hardly any need telling you that if a DX station were obliged to handle the entire load of his QSLs he would have no time to operate. Then there is the little matter of expense to the station which desires the QSL. But to say that a QSL manager gains glory, financial remuneration, ego lift, is open to bribery, etc., is tantamount to libel against the majority of those hams who take their own time, generally spend their own money, and exert their effort to reply for the DX station.

It appears that the foreign amateurs do not understand that the U.S. does not have a free QSL bureau as most of the other countries have. Consequently, when the QSL manager receives hundreds of cards through the ARRL bureau for the DX station he QSLs, it costs him money to reply! This includes the SWL cards, which come in droves.

I fully believe that your author has some ax to grind with some QSL manager. But what I do not understand is why you see fit to print such stuff.

Gay E. Milius, Jr. W4NJF
1416 Rutland Drive
Virginia Beach VA

VK4SS's article really hit home. I have been an extensive QSLer during my 5 years as an amateur. I kept close track of the last 800 cards sent out, which netted 455 returns. I have noticed several trends in QSLing: Returns ranged from a low of 35% on 20m SSB to a high of 80% on 6m (SSB + CW). 40m was about 50%; 15m, 60%; 10m, 65%. CW on all the HF bands was slightly better. DX stations were surprisingly good at almost 70%, and that was by the bureaus. Of about 15 SASEs sent to managers, only one never came back. I never sent any IRCs and very few DX cards direct.

In my opinion the worse ones are the ones who promised QSLs but never sent them. For a while on 20m I asked everybody if they QSLed but it only raised returns a few percent. To those few who said they didn't QSL I still think you're cheap and lousy and no good but thanks for being honest and saying you don't QSL.

Stephen J. Powlishen WA1FFO
53 Oak St.
East Hartford CT

Grommets Spare Your Panel

Occasionally even the best builder will make a boo-boo which sticks out like a sore thumb. Here is a way to avoid one of the most common goofs and one of the more obvious to the casual observer.

Keep a supply of various sized grommets at your drill press and in the drawer with your hand drill. When drilling a hole in an area which for appearance's sake must not be scratched, slip a grommet on the shank of the bit. If you should happen to force the drill a little too much, and the bit breaks through violently, the chuck will not hit the chassis or panel and disfigure it.

.... **Bill Turner WAØABI**

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Schematic Digest Updated For Modern FM Units

As FM gains in popularity with amateurs, schematics and data covering the surplus commercial units seem to get ever scarcer. A company called *Two-Way Radio Engineers, Inc.*, in Boston, has been doing something to ease the situation: This company is publishing a very large (11 x 17 in.) 136-page volume of circuit diagrams, photos, crystal-ordering, and alignment information for most Motorola rigs made during the 1950s and 60s. The book has been updated to include info on even the very recent Motorola transistor rigs such as the Motrac and Motran versions. This new *FM Schematic Digest* covers all the popular models in the 50, 150, and 450 MHz ranges, and sells for $3.95 postpaid. Order from *Two-Way Radio Engineers, Inc., 1100 Tremont St., Boston MA 02120.*

RF Power Amplifier Features Small Size, Printed-Circuit "Coils," Miniature Construction



A unique device that should prove particularly appealing to the FM'er is a tiny (2 x 6 in.) rf power amplifier that will turn a 20 mW FM signal into 10 full watts. The class C amplifier uses silicon transistors throughout and incorporates inductive elements that are "printed" right on the fiber glass/epoxy board.

According to the manufacturer, the compact unit will produce up to 15W with 30–50 mW of rf input. It covers the 2 meter range from 143 to 149 MHz, and requires no tuning with respect to frequency. To be operational, all that's needed is a small signal, an antenna, and a 12V dc power source. Unit is said to be identical to the type featured in the manufacturer's line of "briefcase" marine radiophones. *Dynamic Communications Inc. 301 Broadway, Riviera Beach FL 33404.*

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J. H. Nelson

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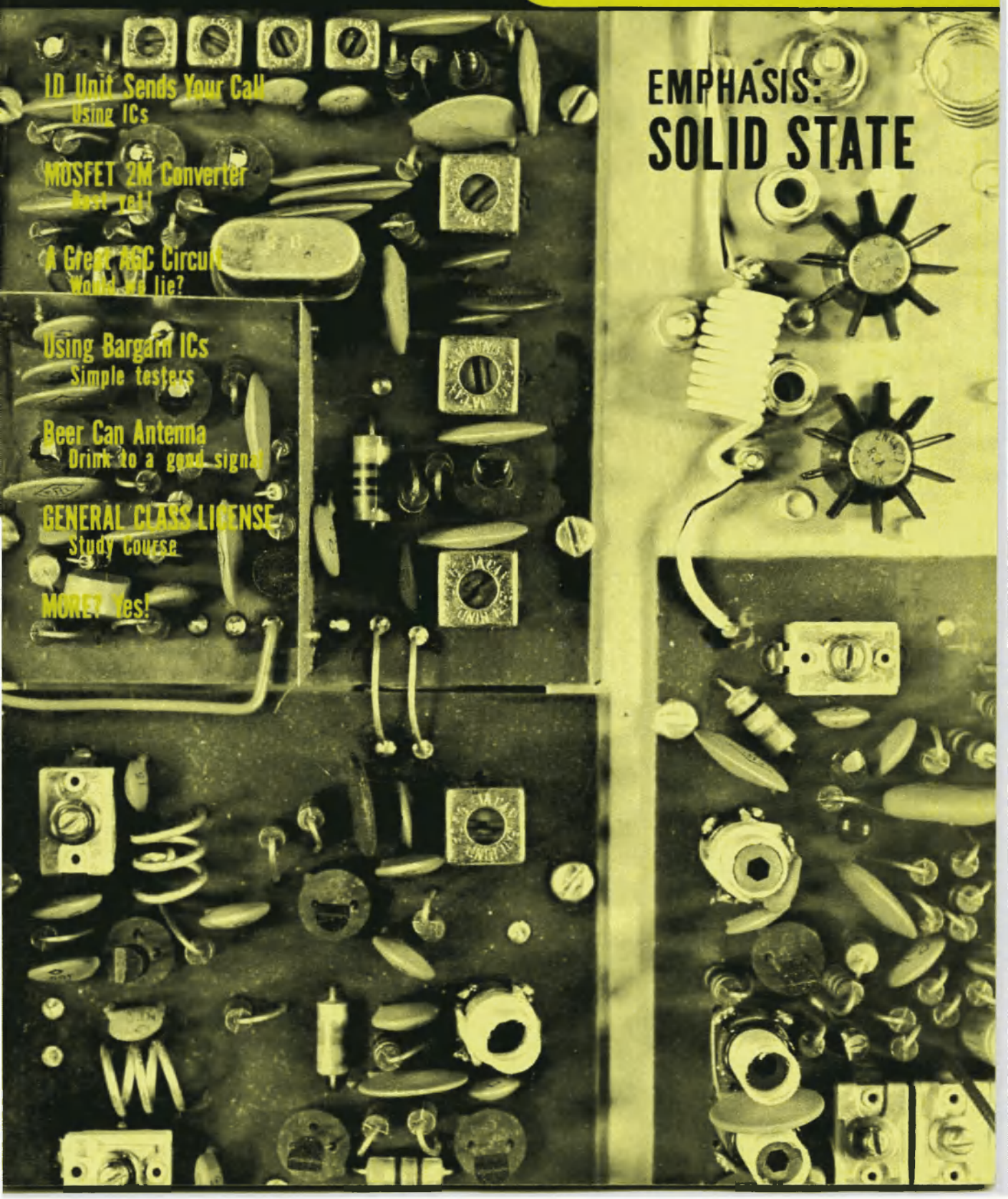
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SOUTH AFRICA	7B	7B	7B	7B	7B	7B	7B	14	14	14	14	14
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A—Next higher frequency may be useful this period
B—Difficult current this period

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Phone: (603) 924-3873.

We do not claim that subscribing to 73 will make you wealthy, yet we cannot overlook the many reports we have received from our subscribers telling us that soon after subscribing to 73 they found buried treasure, fell heir to a fortune, or discovered a pearl in their oyster. It is difficult to overlook the strange coincidence that the magnitude of their windfall seems to always be in direct proportion to the length of the subscription taken to 73. Is a subscription to 73 really a money magnet? Can you afford not to make sure about this? Turn to page 98 please.

Amateur Radio News Page

September XIXLXX | Monthly Ham News of the World | 73 Magazine

HAM SATELLITE FUTURE BRIGHT

Amateur satellite Australis–Oscar 5 has contributed significantly to plans for future satellites in the amateur service. It was the first OSCAR satellite to be launched by NASA; this is an important milestone since secondary payload space is expected to be available on future Thor-Delta launches as the payload capability of that rocket continues to be upgraded. Thus, the next OSCAR satellites under development by AMSAT are being designed specifically to interface with Delta launch vehicles.

The precedent of the command capability proven in the AO-5 mission is very significant, particularly in planning for long-life, solar-powered satellites in the amateur service, and in preparation for the 1971 ITU World Administrative Radio Conference on Space.

The use of command systems should prove a feasible alternative to the adoption of absolute power flux density limitations, so that satellites in the amateur service can be turned off upon command in the event of interference to other services operating in the shared amateur bands. The success of the Magnetic Attitude Stabilization



Members of the Antique Wireless Association admire a rare de Forest radiophone made in 1920 and used by many pioneer stations. WWJ at Detroit used this model when it first went on the air in September 1920. The rig's input power was about 20W. Left to right: K2NP, W2NSD, W2QY, L. Peckham, and K2BX. (Photo courtesy W2KE.)

FCC Steps Up Drive To Nab Violators

Paul J. Bedoian WIHRJ, of Newington, Connecticut, was cited by the Federal Communications Commision for "repeated violation of Amateur Rules, Section 97.7(b)." According to an FCC public notice, Bedoian operated his station "on a frequency not authorized." The FCC report listed the fine at $100, but gave the amateur 30 days in which to respond to the allegation.

In Monroe, Michigan, Richard Brown WA8YDZ was also cited for the same violation, as was Paul Angelides WA2YHK, of Middle Village, New York, and George White W1MPW, of Waterbury, Connecticut. In all cases, the fine was listed as $100.

The FCC doesn't just issue notices

System demonstrated that this technique is a most attractive one for future satellites.

The precedents established in international group cooperation among amateurs, and the training and educational benefits derived from the design, construction, testing and flight of AO–5 will also be of great usefulness in future radio amateur satellite projects. (Material furnished by AMSAT Newsletter.)

American Radio Club Formed

A small group of active amateurs gathered recently to see if they could provide the nucleus for action that seems needed to further the interests of amateur radio in the U.S.

A group of basic goals was agreed upon:

1. To work toward getting more amateurs in the U.S.
2. To recommend band allocations relevant to current use.
3. To protect the future of our hobby in Washington.
4. To protect the future of our hobby in the ITU.
5. To encourage discovery and development by amateurs.
6. To work with all other clubs and groups to strengthen amateur radio.

It was decided that the editorial policy of 73 Magazine best reflected the nonpartisan approach to amateur politics and that this magazine would be designated as the official club bulletin, providing this was agreeable with the publisher (it is . . . pub.).

The American Radio Club will accept bids from groups of amateurs interested in establishing Chartered Regions of the Club. A list of the founding members, the area included in the Chartered Region, the proposed Club, c/o 73 Magazine, Peterborough, N.H. 03458.

US Ham Mag Wanted by Reds

73 frequently gets letters from the Iron Curtain countries saying that it is impossible for the amateurs there to send money for subscriptions to 73, yet they find the magazine of tremendous interest and each copy is almost read to pieces it goes through so many hands.

If you would like to sponsor a subscription for a club please drop us a note and include $10 for each three-year gift subscription. We will start down our list of requests and go as far as we can. We will also drop a note to the club telling the amateurs who you are so they can let you know that the issues are coming through and are appreciated. While they can't send money, they can send through some really great phonograph records, records completely unavailable here, and things like that as gifts of appreciation.

If you already have a club or individual you would like to sponsor, send along that name and address for us. They must be in a controlled-currency country such as Poland, Czechoslovakia, Hungary, Russia, etc.

Speaking of which, just to give a little political zing to anyone who thinks of the U.S. as being imperialist, it is interesting to note that the U.S. has gotten out of every one of the 21 countries it has occupied since the beginning of the war, while our friends in Russia have left only one, Austria, and that one under a great deal of political pressure. So much for the capitalist imperialists.

Unlicensed Radar Brings Challenge

A California resident, irate over a traffic citation, told city council this week he is going to enlist the aid of the Federal Communications Commission in his battle with the local police department.

Dale Rohde, of Cypress, claimed the city's police were operating radar equipment without a federal license when he was issued a speeding ticket July 3.

Unless all the traffic citations obtained in this method are dismissed, he said a federal warrant would be sought against the city for violation of a section of FCC regulations, which governs the operation of public safety radio equipment.

The maximum penalty for each violation, Rohde said, is a two-year sentence and a $10,000 fine.

"I hope you gentlemen realize a municipality in the San Francisco area wound up paying $28,000 in an instance similar to this," Rohde said.

City Administrator Robert Huntley said the unit is presently inoperative and "it did not have a license."

Huntley added that Chief Conner Collacott, however, was "under the impression" the unit had been licensed.

Rohde asked council what action it intended to take.

"What do you want us to do?" asked Councilman Frank Fry.

"I don't think it is unreasonable for all these citations to be dismissed," said Rohde.

Nevertheless, Deputy Dist. Atty. Richard Beacom indicated the DA's office is planning on prosecuting the cases whether "the unit was illegal or not."

and forget. A number of amateurs are now getting nailed for failing to respond to Commission letters. Dennis Mitchell WA8ROJ, of Milan, Michigan, has been ordered to "show cause" why his license should not be revoked. His violation: failure to reply to official communications. And Martin Higgins WA6AGX, of La Crescenta, California, simply failed to give the FCC some information that had been requested. He, too, has been ordered to show cause why his license should not be revoked.

The Commission has at long last begun to act on the many cases of on-the-air jamming taking place in the ham bands. Robert Brickey, of Orem, Utah, who is holder of licenses for W7QAG, W7ABU, and WA7BTS, has been ordered to show cause why all his licenses shouldn't be revoked for "willful and malicious" violation of Sections 303(m) (1) (E) of the Communications Act of 1934 and Part 97.125 of the Amateur Rules. According to the FCC report, Brickey's stations were used "to interfere with" radio communications or signals of another radio station.

RADIO ANTENNA SUIT

An injunction suit is on file in Superior Court in which the City of Fresno seeks to force Patrick C. Fennacy to shorten a crank-up tower from 71 ft to a maximum of 25 ft and to obtain abuilding permit for the structure. According to an item in the Fresno Bee, the suit alleges Fennacy built the tower after the Fresno City Planning Commission turned down his request to erect it so high. The suit says the tower is a public nuisance. The amateur who submitted this report to 73 also said that "ARRL is reported as being uninterested."

WORLDWIDE DX NEWS

INTERNATIONAL DX ASSOCIATION FORMED

If you have been listening on 14220 at about 2330Z for the past several months you have heard reference made to a new international DX organization currently in the formative stage. The history of this effort goes back over several years and is long and involved. Let is suffice to say for now that Aubrey Spear WA5REU, Arden Hopple W3DJZ, and Eva Perenyi PY2PE, are more or less at the bottom of the deal.

During the past several weeks a few ideas have begun to jell and we now have a rudimentary organization still subject to change on short notice. The dues are to be $2 per year, also subject to change on short notice. In my possession is a document which was formulated by Aubrey and about a dozen other well-known DX'ers last April at the Dayton Hamvention. This document proposes certain aims and objectives of the organization. Such things as international goodwill, promotion of camaraderie, and good fellowship among amateurs (and other such hogwash) are mentioned.

However, the real meat of the thing is Objective II, which states "To finance DXpeditions, to furnish radio equipment to deserving amateurs throughout the world who are unable to do so for themselves for one reason or another." In short, the objective is to place radio equipment where it will the address shown below. In any case, join the PRS gang (Pandemonium Reigns Supreme) on 14.220 MHz at 2330Z any night in the week. You can get the latest DX rumors for free. For example, I worked ZA1C at 1643Z on 21275 kHz July 5, 1970 and he is for real (maybe).

CW PRACTICE BROADCASTS?

One of the ARRL services that is helpful to virtually every prospective amateur is the Morse Code broadcasts by W1AW and W6OWP. There is really no reason why these two stations should have a corner on the code practice market.

Just as we have established a Technical Aid Group in the pages of 73 (TAG) for answering technical questions from readers, we would like to establish a Code Practice Group. If you are set up for sending code practice sessions with your station and are willing to establish a fixed and ragidly unchangeable schedule for broadcasting, please let us know your time, frequency and code speed to be transmitted.

CPG stations should have automatic means for sending code and a substantial signal. While we think that the best bands for code practice are the 80 and 40 meter bands, there obviously is a need for some service on 20, 6, and even 2 meters. We ask that all CPG stations register with 73 so their schedules can be published and that when they come on the air, they check the scheduled frequency for activity and settle in plus or minus enough to avoid jamming contacts or nets in progress.

We suggest that code practice sessions consist of both plain language and coded groups.

CAN THE FEDS SEIZE YOUR GEAR ?

Yes, they can. And sometimes they do. As in the case of CB "skipper" George Bennett, for instance. George, better known to the local CB crowd as "Unit 909," had all his radio equipment confiscated by order of the government.

The Detroit man had been convicted of violating a U.S. District Court injunction against operating an unlicensed CB station, and received a six-month suspended sentence and a full year's probation. Then they came and took away his rig.

The reason his station was unlicensed, by the way, was because his license had earlier been revoked. The reason: "... flagrant violations of FCC rules." But despite the revocation, the severe warnings from the Fed, and the court injunction, Bennett just couldn't keep his hand off the switch. Now he doesn't even have a switch.

ONCE AROUND THE WORLD... *W2NSD/1*

C31AH (Gaston), gets on now and then from Andorra, but he has so far neglected to contact me. C31, what kind of nonsense is that? That's worse than that old CR10 prefix. Gaston, by expect to zip on down there for the awards banquet October 22nd. Hope you can make it too; there should be quite an interesting bunch there. FW8BO has been on recently around

MICHIGAN HAM WORKS GERMANY ON VHF

Fourth-of-July F2 conditions permit intercontinental QSO on 6 meters

When George Kerr (W8QNY), of Jackson, Michigan answered a CQ on the 4th of July, he thought he was making contact with South America. It took a little beam-spinning before he discovered he'd made an F2 contact with an amateur in the northern part of Germany.

"His signal was weaker to the south," George said, "so I worked my three-element Telrex toward the east ... He got my call straight when I was beamed southeast."

George said he learned the fellow, Peter, was transmitting from Keil, Germany, and talked with him "for about 30 minutes before the band dropped out."

do the most good to eliminate the word "rare" in rare DX. Considerable satisfaction can be derived from helping individuals like Sid (ST2SA) get on the air with SSB equipment. As a matter of fact, an HW-100 is on the way to Sid at this moment. Several projects which are currently in the works are: (1) An antenna is being sent to Africa in a TY/TZ effort; (2) the such discussed equipment for ZK1AJ has finally been located in Christchurch and is again on its way to Manihiki, Niue, and Tokalaus; (3) assistance was furnished for the recent highly successful Zanzibar operation; and (4) the Albania effort by OH2BH was supported.

It is quite obvious that, should this organization hold together and become productive, the demand will far exceed the supply. An HW-32 plus accessories plus AC/DC power supply costs about $200, not to mention the devastating cost and problems of getting it where it will do some good. Obviously, it will take support from large numbers of DX'ers to handle many such projects. Herein lies the main reason for the formulation of this group. If, for example, 2000 DXers want to contribute $2 per year, several stations could be sprinkled around the globe. Substantial contributions could be made to other individuals and groups planning DXpeditions of their own. Then, when the bite is put on you, you can say you are a member of "International DX Association" and have already contributed.

A final charter, ground rules, officers, etc. are being worked. However, it will be several months before such a final document is ready for distribution. In the meantime, useful and interesting projects are under way. If you feel that you would like to join such an effort, send your $2 to me at the way, is QSL'd via REF.

EP2DX is on fairly regularly from Tehran. QSL to W3HNK for Rick.

Funny about some of the phonies ...1A1A came on and immediately every smart op knew that this was a lead balloon, yet some of the thicker oldtimers continued to create pileups for this sickee for days. Ambrosia Island, good grief!

Biu, PY4AP, points out that he is not the QSL manager for PY7AWD/Ø. This station is now operating as PYØ Box 2, Fernando de Noronha and should be QSL'd direct. He speaks no English, so good luck. The Bermuda contest was hurt a bit by poor conditions, though VP9's AT, BY, CP, DL, FU, GD, GE, and MI were very busy anyway. Everything being equal, I 1200Z on 250. AX9KY on Cocos can be heard about the same time. 4S7AB is on 15 these days. FG7AC has been busy with all those DX'ers who need Guadaloupe, and there are thousands. VR5LT, Bill, Box 49, Tonga, South Pacific, was listing it up with W5GG doing the honors and gladdening a lot of hearts at 0330. There hasn't been much on from there since the old Miller daze. A CQ directed at the Middle-East brought an answer from 7X2SMA In Algiers (P.O. Box 2), where Boualem is doing his best with low power AM. 5R8AP (Buddy) has been on often recently, working the pileups by the prefixes. Nice signal and QSL to WB4GQH. By the way, when you are in Bermuda you can look up the local amateurs in the Yellow Pages under "Ham Radio."

OF LISTS AND SUCH...

The International DX Association meets nightly at 2230 on 14.220 for an orgy of list-working rare ones or else an orgy of boasting. Either way it is fun. They also get in a little time to scheme up new DXploits, figure where they can send a rig that will do some good, etc. Check in with K3RLY or PY2PE. Eva puts a horrendous signal into the entire U.S., so you can't really miss her charming voice and wry wit.

The other night the list featured a quickie with CE9AT down in the South Sandwich Islands. There are a few spots rarer than that, but only a few. The night before they were making the same scene with XT2AA, another beaut.

Lists are the order of the day for working 5R8AS, Chet Cunningham, down in Tananarive on Monday nights. He'll be there until December if you need a 5R8. Check in with Herb W6FQ at 0400 on 14.220. Chet is the director of the NASA tracking station down there.

Some ops are discourteous enough to get on the list, wait their turn, and then take the time of those still waiting to tell the DX op that they don't like lists. Bad manners. Boorish. Ugly. Okay, there are several ops that find their ego offended by having to get in line with the ordinary run-of-the-mill DX'er. They would much rather smash through a pileup to get their rare ones. It satisfies their need for prestige and proves their superiority to themselves and everyone else.

It all makes the list seem more worthwhile when you think it over.

ALBANIA ACTIVATED

Martin, OH2BH, operated for several hours from inside Albania in mid-July, giving some 700 enthusiastic DX'ers a contact with this rarest of countries.

Amateurs have been trying for many years to get permission to operate from Albania, but there have been no legitimate operations for at least 25 years. The few clandestine operations were short-lived, though they have been accepted by the ARRL for country credit.

There is some question about the validity of the OH2BH operation as far as official permission is concerned, with some interested parties being quite convinced that this operation, like its predecessors, was cladestine.

The cables received by amateurs in Finland and Sweden were short and perplexing: "Demonstration over, rig lost." The fact that Martin was able to return to Finland from Albania lends credence to the opinion that this might have been a legal operation. Word has it that, legal or illegal, credit will be given for ZA by ARRL to the 700 lucky ones who got through the pileup.

Foreign 73 Agents!

Please include call letters on all inquiries about subscriptions. 73 files subscriber names according to ZIP codes, but since foreign countries don't use ZIP, the only logical file system is by ham call. A mention of the call will save a tremendous amount of time in the troubleshooting department.

Thanks.

FCC-APPROVED ID FOR CONTESTS

by James E. Barr
Chief, Safety and Special
Radio Services Bureau

Since the fall amateur contest activity will soon be here, a number of amateurs may be interested in a resume of a recent explanation of what the Commission considers to be an acceptable station identification, as follows:

For compliance with rule Section 97.87(a), the last transmission of the exchange of transmissions with another station must include the "other" station's callsign. For example, "BK 589 CAL TU DX1DX de W6XYZ K" would be in compliance with $97.87(a). When there is a need for identification of the "other" station in an exchange for the benefit of our monitoring facilities, it is most likely to be heard if it is in the last transmission or at the end of a long single transmission.

Where the transmissions of an exchange are very brief, such as the typical contest exchange, if it is less than 30 seconds duration, the entire last transmission is considered the "end of the exchange" for the purpose of compliance with $97.87(a). Provided there is no mistaking which is the transmitting station's callsign, the callsigns may be anywhere in such last transmission. While the rule no longer gives examples, continuation of the traditional practice of placing the transmitting station's callsign last or preceding it by "de" is acceptable for this purpose.

Examples of acceptable end-of-exchange transmissions of less than 30 seconds are:

"CS1DX de W6XYZ 589 CAL BK"
"DX1DX W6XYZ 589 CAL K"
"DX1DX 589 CAL de W6XYZ K"
"DX1DX 589 CAL W6XYZ K"
"589 CAL DX1DX W6XYZ K"

For telephony, the voice equivalent of the foregoing examples may be used, substituting "this is" or "from" for "de," etc.

PRESS LETTING HAMS DOWN ?

The Society of Wireless Pioneers has expressed concern at the failure of the press and all media to mention or recognize the vital part radio officers play in the saving of lives and property during emergencies.

A case in point, according to an SOWP news release is the sinking of the *S.S. Badger State* Dec. 26, 1969, in which radio officer William Lafay-

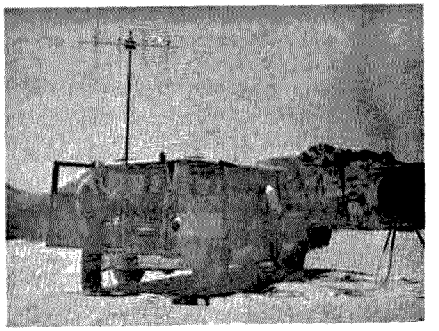
"Trader Jim" Suffers Fatal Heart Attack

James S. Sommerville, (W9WHF), known to thousands of amateur radio and Citizens Band operators the world over as "Trader Jim," died recently of a heart attack.

Mr. Sommerville was a senior technical correspondent for Allied Radio Shack, Chicago. He acquired the nickname "Trader Jim" during the years that Allied was active in the trade-in communications equipment business through the mail.

An active Ham for more than 33 years, he had an earnest desire to help young people get started in amateur radio.

ATV MOUNTAINTOPPING



Three enterprising television amateurs – Dick Nickel (W6PCQ), Chuck Phillips (WB6WPQ), and Dan Fix (WA6DNY) – escorted their portable television and radio gear to the top of Santa Monica Mountains as a project of the ATV Club of Southern Calif. The reason for this tiring trip was to create wider interest in amateur radio through the modern concept of amateur television.

Mountaintopping is a standard for amateur radio activity on Field Day. However, amateur television is another story. Aside from the normal problems, there are sync pulses and video scanning, all of which must be generated or must be compatible with the 60 Hz commercial electrical line frequency.

The only source of electrical power used was a 12V electrical system from the 1969 Dodge van which was their only transportion. A 300W 12V-to-110V inverter furnished the end power source to the radio and television equipment. This supplied enough power to alternate between the available equipment.

A FAREWELL TO A PIONEER

by Mrs. Patricia Armstrong

In a geriatric home in Melfort, Saskatchewan, Canada, an event occurred that in one way was not important outside a small family circle, but in another was important to all hams everywhere. This was the death, in his seventy-third year, of Oscar Olson, a radio ham of forty years standing. Like the majority of his fellows, he was known locally by his name to only a few people, but internationally to many by a set of letters and figures. (Oscar's were VE5DS.) Is his passing not an occasion for North American hams to lay aside their microphones, hush the clatter of their code keys, and pay a moment's silent tribute to members of a fast-disappearing group: the pioneers of our own profession?

Okinawa Award Rules Change

The Okinawa Amateur Radio Club has recently revised requirements for the Okinawa Award, as follows: 25 QSLs are required for applicants from KR6 and KR8; 10 QSLs are required for BV, CR9, DU, HL/HM, JA/KA, KG6, VS6, W/K applicants. For the best of the world, 5 QSLs.

KR6 & KR8 applicants must submit cards for verification. For all others, send only a logbook extract with signed confirmation that required QSL information had been reviewed and verified by two licensed amateur radio operators, or by an official of a recognized radio club or society.

Send all applications, together with $1 (U.S.) or 10 International Reply Coupons, to QSL & Awards Manager, Okinawa Amateur Radio Club, Box 465, APO, San Francisco CA 96331.

ette lost his own life but was able to send the SOS which resulted in rescuing 14 members of the crew, including the captain.

Checking into the matter, the Society found that Officer Lafayette carried out his duties in an outstanding manner and he was complimented by all who worked with him in the handling of this emergency. *However* . . . not one word of this man's heroic devotion to duty found its way into press releases. Nor did any of those rescued give him recognition in their press interviews.

The Society suggests "monitoring" of press releases in newspapers, magazines, and other media, and contact the editor in the event of such omissions. The anonymous spokeman for the Society of Wireless Pioneers said. "We are proud of our heritage and the many brave and valiant men who have lost their lives in carrying out their duty." *What more can one ask?*

New Transistor Runs 90 W OUTPUT on 2m FM

A new silicon rf power transistor from Motorola (type MM1552), is rated at 90W peak output power, with an rf input of 18W, according to Jack Jaques, engineering director at Motorola Semiconductors,. of Phoenix, Arizona.

Intended for use as high-power Class C amplifiers for 100–175 MHz frequencies, the transistors have the high peak power capabilities and breakdown voltages required for AM service. The MM1552 permits close to 100% modulation with a 25W carrier at V_{CC}=13.5 Vdc. In FM or CW service, the new transistor is capable of a *continuous* 75W output at 150 MHz. The 65 V BV_{CES} of the MM1552 permits high level modulation with a 13.5V power supply or series modulation with a 27V supply. The transistor derives its electrical ruggedness from "balanced emitter" construction – it can withstand all conditions of load mismatch in AM service, from short to open circuit. Much of the fine broadband performance of the transistor comes from its low-lead inductance *stripline* package. The price is $43.50 each. An application note describing at 25W, broadband, amplitude-modulated transmitter employing the MM1552 may be obtained by writing Motorola directly.

New Mexico Hamfest To be Biggest Yet

The Albuquerque Amatuer Radio Club and Caravan Radio Club of New Mexico will sponsor the New Mexico Hamventon at Albuquerque, New Mexico on September 18, 19, and 20. This will coincide with the New Mexico State Fair which is being presented from the 17th through the 27th of September.

The Hamvention headquarters will be at the Holiday Inn East, East Highway 66. There will be a banquet on Saturday night (September 19) in the main ball room of the Holiday Inn. There will be lots of door prizes, Gabfest, flea market, and lots of fun. Technical sessions will be presented in the areas of VHF, FM, SSB and other subjects. There will be MARS meetings and the VHF FM Society of New Mexico will have its first formal meeting. Planned guests include Ken Sessions (Repeater Handbook) and Bill Orr (Radio Handbook).

Talk-in frequencies will be: 3990, 7293, 14345, and 29600 kHz (AM and FM), 146.34–146.94 MHz (Repeater), and 146.94 MHz (direct) NBFM.

For further information and registration, contact Ray Hill, W5SDM, 9016 Los Arboles Ave. NE, Albuquerque, New Mexico 87112, (505)299-1719.

Ham radio is a quiet hobby, little known beyond its own warm circle, but persistent, and limited to no one nation. Oscar Olson was rather like that himself. Born in Sweden on December 1, 1897, he was transported at the age of seven by ship, train, and finally horse-and-buggy to a homestead near Stenen, Saskatchewan. There he grew to young manhood, working on his father's farm and exploring, in his free time, the scientific marvels of a dawning age. For forty years he was a ham operator. He left behind a stack of yellow radiograms and logbooks dating back to the 1920s. To browse through them is to recapture the history of the humble community in which he spent his life.

In 1926, when Oscar was formally licensed as a ham operator, radio was in its infancy. Enthusiastic amateurs were building their own crystal sets, straining breathless to hear through the crackling static of headphones, undaunted by the envious jeers of less-skilled neighbors.

What goes into the making of the 300,000 licensed amateurs of the North American continent? They are ordinary men and women who patiently learn Morse code, who sit for endless hours fiddling with dials, sorting out beep-beeps from every country in the world, discussing reception, frequencies, trivialities hour after hour, day after day, week after week. Suddenly, perhaps, one may leap into the spotlight of public acclaim at a time of national emergency like a flood or a cyclone. Most live and die "unwept, unhonored, and unsung." What starts them on their dedicated path? What spell holds them to it in spite of daily tedium?

Of course no two hams are identical. Yet surely all of them must share one common trait – the love of tinkering. Most of them originally construct at least a part of the equipment with which they work. In the early days that we are remembering just now, perhaps they constructed all of it.

Oscar belonged to a type that is disappearing in this day of standardized technical education. He was a self-taught enthusiast, a man who developed a natural skill without the help of formal education.

Today one turns the leaves of those logbooks that record the daily radio contacts of forty years, and marvels at the neat script which would put to shame most high school students of our own day. One gazes at the painstaking sketches of mechanical apparatus that apparently interested him – sketches that, to an untrained eye at least, look like the work of a professional draftsman. For many years Oscar kept a radio sales and repair shop in Sturgis. He also farmed with his brothers Andrew and Eric. Oscar was the one who repaired things – radios, farm machinery, whatever in the neighborhood broke down. The boy who put his clocks back together never gave up until he found what kept the radio or the tractor from functioning.

Oscar is survived by a wife and four sons. His ham equipment sits in his Sturgis home, dismantled now, awaiting the time that one of the boys will, perhaps, establish a permanent home and take up his father's hobby.

During the two and a half years after the stroke that ended his days at radio and key, who knows what Oscar thought or what he remembered? But we remember him – and the thousands like him who put their bits of scrap together when the country was young, and started, for good or ill, man's conquest of the airwaves. Let's pause a moment now, and toast them all. Ladies and gentlemen, I give you the pioneer hams of North America. May God bless those who still live, and the memory of those who, like Oscar Olson, have passed beyond the reach of key and code!

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. Include your check with order.

Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

For $1 extra we can maintain a reply box for you.

We cannot check into each advertiser, so Caveat Emptor. . .

ELECTROMECHANICAL TIMER — A reader recently wrote 73 asking where "veeder root" type counters could be obtained. We got the info but lost the writer's letter. Counters are available from J. Meshna, 19 Allerton St. Lynn MA 01904. Order No. 68-38, $1.75 postpaid.

CINCY STAG HAMFEST: The 33rd Annual Stag Hamfest will be held September 27, 1970 at Stricker's Grove, Compton Road, Mt. Healthy, Cincinnati, Ohio. Door prizes each hour, raffle, lots of food, flea market, model aircraft flying, and contests. Identify Mr. Hamfest and win prize. $5.00 cost covers everything. For

TECH MANUALS — R-390A/URR, BC-639A, OS-8C/U, SP-600-JX, R-274/FRR, Ted, $6.50 each; TX-175/U, TX-323/UR TS-173/UR, $5.50 each. Hundreds more. S. Consalvo, 4905 Roanne Drive, Washington DC 20021.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd PA 19004.

RBB-RBC MANUALS: New $5. Used $4. OS-8 Oscilloscope manual $3. Some QST 1929, 30, 31 etc., Radio 1939, 40, 41 etc. Write for list. James W. Holloway W6LFL, 2027 Harton Rd., San Diego CA 92123.

SAROC: January 7-10, 1971, Flamingo Hotel Convention Center, Las Vegas, Nevada. Sponsored by Southern Nevada ARC, Inc., Box 73, Boulder City, Nevada. Advance registration $14.50 per person accepted until January 4, regular registration at door, includes Flamingo Hotel late show and drinks, Sunday breakfast, cocktail parties, technical seminars and meetings, ARRL, DX, FM, MARS, QCWA, WCARS-7255, WPSS-3952 and WSSBA. Ladies program. Flamingo Hotel SAROC room rate $12.00 plus room tax, per night, single or double occupancy January 3 thru 12, 1971. Mail accomodations request to Flamingo Hotel. Mail advancce registration to SAROC. W7PRM, Club President. W7PBV, SAROC Convention Chairman.

"TOWER HEADQUARTERS!": 11 Brands! Heights aluminum 35% off! Strato crank-ups-low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co., Stanley WI 54768.

END CARD PROBLEMS: Frame, protect, store or display 200 QSL's in 20 card plastic holders for $3.00, prepaid and guaranteed. Tepabco, Box 198, Gallatin TN.

HT-37, $169.00: R4-A, $279.00: Ham-M Rotor, $79.95: HQ-180, $225.00. Moory Electronics, Phone 501-946-2820, P.O. Box 506, Dewitt AR 72042.

DECIMAL INDICATOR TUBES: 1/2" characters 0-9, no decimal point. Similar "Nixie" B5750. Brand new, guaranteed, $3.50 ppd. SASE full information. W1DMU, box 1, Corinth VT 05039.

6-METER STATION: Clegg 99er transceiver, matching VFO, Hy-gain 3-element beam. All excellent condition. WB2MRJ Mark Freedman 67-IOC 190 Lane, Fresh Meadows NY 11365. 212-GL4-8194.

RG8U or RG11U: Low loss foam coax 10¢ foot PL259-SO239 40¢ each, 15/$5.00. Jacketed ½ inch aluminum 50 ohm foamflex 20¢ foot. New factory sealed Ham-M Rotor $95.00. Everything new! Monte Southward Co. RD. 51, Upper Sandusky OH 43351.

SURPLUS GOODIES — Two radio remote control units RM-39: $7.50 each; two EE-8 telephones: $7.50 each; BD-72 Switchboard (12 lines): $10; five BC-611 walkie-talkies: $10 each; two BC-745 AM 80 meter portable transceivers with rechargeable pwr supplies: $10 each; 60 watt GE rcvr and xmtr, 30-40 mc., 6/12 volt, FM: $17.50; Metal detector SCR-625: $25. All items FOB. Will answer all replys. William S. Weir Wb4GEW, 322 Forest, Berea KY 40403.

FOR SALE: best offer DX 100, SX100, DX 40, DX 60, Globe 90, TBS 50, BC 348, RCA 88LF, ip501, Marconi LF, omega 4 x 5 enlarger, HT40 RCA 8506B, ARR 8503, all in working condx. Write Box 8352, Savannah GA 31402.

NOVICE CRYSTALS: 40-15M $1.38, 80M $1.83. Free Flyer. Nat Stinnette Electronics, Umatilla FL 32784.

POWER/MATE MODEL: UNI88 precision 0-34 volt power supply at 1.5 amperes equipped with controls and metering arrangement 27.50 W2TJZ 101 Christie St., Tenafly NJ 07670 07670. Phone 201-568-1267.

RECORD GRAB-BAG, from personal stock, 10 new 45 rpm records, variety music, $1.00 postpaid USA. Don Whitney K5GKN, Box 249, Osceola AR 72370.

FOR SALE: CE20A with QT1, CE458 VFO $85.00, 2A with xtal calibrator $135.00. Both $200.00. Don Whitney K5GKN, Box 249, Osceola AR 72370.

DRAGON FLY. . .antenna, for 20—40—75 meters. . .no traps. . .no compromise. . .eight months in development. . .one feed line. . .SWR one to one guaranteed. Construction drawings $5.00 Box 423, Wakefield, RI 02880.

NATIONAL 1000, one kilowatt transceiver, 80—10 meters, brand new, used for short test for 73. Cost $1100. Send check for $900 and it is yours. Factory guarantee. 73 Magazine, Peterborough NH 03458.

Hamfests and Other Happy Occasions

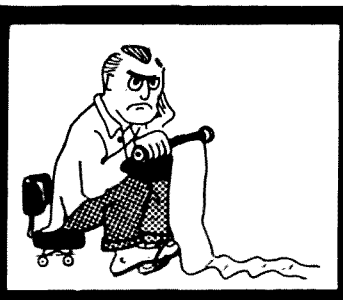
Oklahoma

The annual hamfest at Lake Texoma Lodge on Lake Texoma, near Kingston, Oklahoma will be held this year November 13, 14, and 15th.

All the programs will be indoors

California

The 9th Annual Greater Bay Area Hamfest will be held at the Edgewater Hotel in Oakland, California on October 18—19th of this year. For the 10,000 amateurs in the San Francisco



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

The FCC jammed through its contribution to inflation, the rule that increases the cost of an amateur license from $4 to $9 for five years. I suppose this isn't so bad in the context of $2 movies (how many of you can remember those Saturday afternoon matinees with two main features, one western, two serials and six cartoons for 10¢?) and teensy 25¢ ice cream cones.

The argument against raising the ham tax was that we need to turn every stone we can to get more hams, and anything that could possibly slow down the entry or continuance of amateurs should be avoided. Like more than doubling the tax. It probably wouldn't have bothered many of us so much if there had been a raise in the tax on the commercial licenses, the permits to make money.

At any rate, starting immediately you will have to pony up $9 and there doesn't seem to be much to be done about it. A good lobbyist for amateur radio in Washington undoubtedly could have stopped this, but we don't have a good lobbyist in Washington, only a part time unpaid cheapskate who doesn't even have the fare to get to Washington half of the time. You got what you paid for.

ARRL National

Newington hated it, but they grudgingly permitted 73 to exhibit at the Boston ARRL National this time. Last time they turned thumbs down and 73 was not permitted to have a booth. They did remain adamant that none of the 73 staff be permitted on the program so (unless some special arrangements can be made) you will miss hearing about FM and repeaters from Ken and miss seeing my slides of King Hussein and Jordan. Too bad about that, but that's the way it is with ham politics.

W2NSD/1 Nightly Sked (wife permitting)

Last month I set up a schedule on 14.300 MHz nightly at 0200Z, plus whatever time after that it takes me to remember the schedule, and providing my wife hasn't yanked me out to the movies or something. After a few nights on 14.300, I want to publicly express my sympathy with the 141,000 General and Conditional licensees who are stranded in that unbelievably crowded band segment. Normally I operate down around 14.210 or so, and while there is QRM there most of the time, it is usually on the order of S8 or so. On 14.3 the QRM is seldom below +10 over 9, and frequently squashes any signal below +30.

At first I was going to set up shop on 14.280, but after a couple nights of trial I gave up the idea of trying to work in between all of the nets that are set up there. 14.300 seemed better in that at least there did not seem to be any organized activities there.

Try me on 14.300 if you have any traffic. I have a big signal and will try and pave a way for you to get through. I'm looking for any information that might be of interest for the news pages, things like DX news, emergencies, medicine to save babies, or whatever you think might be of good general interest. Please do not call in about subscriptions, advertisements, JY1 cards, or anything commercial.

Anecdota Wanted

Jean Shepherd K2ORS called the other day to say that he has started work on a book about amateur radio aimed at the youngsters. He would like to hear from any amateur who has had an unusual experience that might be worth including in the book. Have you been involved in anything unusual or exciting which might be worthy of inclusion in a book about our hobby? Send the particulars to us to pass on to Shep. Send the stories to Shep, c/o 73 Magazine, Peterborough, N.H. 03458.

Mideast Perspective

Though I try to keep up on worldwide current events, and probably do more than most people, I found myself woefully short on anything more than generalities when I went to Jordan. The impression I had from the usual flow of Mideast news in the U.S. was that Israel had made just about every concession possible in an effort to get the fiery and intransigent Arab leaders to sit down and try to work out a peace arrangement.

While I was in Jordan I naturally heard quite a bit of the other side of the story. The rather extensive report by Newsweek, a magazine that I have come to trust down through the years, was strikingly similar to the evaluation of the situation I had been hearing in Jordan and this cast some doubt in my mind about the objectivity of

(cont. on page 108)

further info, contact, John Bruning, W8DSR, 6037 Fairhurst Ave., Cincinnati OH 45213.

WANTED: SP4OOX Chassis with Tuner. Ralph M. Williams, Box 372, Dixfield MA 04224.

HAMVENTION: Albuquerque, New Mexico on 18, 19, 20 Sept. 1970. Lots of door prizes. Gabfest, Flea Market, Technical sessions. MARS, VHF, SSB, DX meetings. For Information and registration contact Ray Hill, W5SDM, 9016 Los Arboles Ave. NE, Albuquerque NM 87112, Phone area code 505-229-1719.

FM GEAR: P/O AN/TRC-28. 50W 150 MHz Base. T-416/GR, R-394/U, PP-804/U, C-844/U, CY-122/G cabinet. 115/230 VAC. Xceive, 2W Remote, Repeater options. W/Books, Handset. 1 ea. L/N $45. 1 ea. Unused $55. 1 ea. Remote (C-845/u) Unused $10. 1 ea. Base plus remote on 146.34/146.94T, 146.94 W/1800, 1950, 2100, 2250, 2400, 2805 burst built into remote unit, unused $95. Freight collecto or you P/u. SASE for list of Hiband and UHF FM gear. Jack Krause WA6OBH, 8513 Don Ramon Drive, Stockton CA 95207.

CRYSTALS AIRMAILED: Novice — all bands, all frequencies, accurate-active — $1.50 airmail 10¢/crystal, 1st-class 6¢. Free amateur experimental general frequency price-order bulletin. Your crystal shop since 1933. WØLPS. C-W Crystals, Rt. #2, Marshfield MI 65706.

VIKING INVADER: 2000 perfect clean condition with electronic tr. switch and factory fitted RTTY, need space, bargain $350 K8UBG, 1137 Cedar Point, Sandusky OH 44870.

COLOR ORGAN KITS: Home/Auto $7.50. IC power supplies $2.75 to $8.50. Computer grade electrolytic capacitors $.35. XMTR transistor TRW PT3690 $4. Catalog. Murphy, 204 Roslyn Ave., Carle Place NY 11514.

ELECTRONIC ORGAN, solid state, spinet, send SASE for particulars; Lloyd G. Hanson W9YCB, RR 2 Box 52A, Angola IN 46703.

GREENE: center dipole insulator with ... or ... without balun ... see November 73, Page 107.

WORLD RADIO's used gear has trial-terms-guarantee! KWM2, $695.00; Duobander 84, $104.95; Galaxy 5 mk2, $259.95; 5 mk 3, $279.95; GT550, $379.95; 2NT, $119.95; Valiant, $129.95; SB2LA, $149.95; R530 receiver & 3 filters, $649.95; Interceptor 6/2, $199.95; 75S1, $299.95; HQ170C, $179.95; Drake 2A, $159.95; F455B60, $19.95; GC104, $19.95; Swan TV2(20M), $199.95. Free "blue-book" list for more. 3415 West Broadway, Council Bluffs IA 51501.

SURPLUS CRYSTAL FILTERS, dime for list. Over 50 types, 80 kHz to 36 MHz. See Aug. 73 ad. ESELabs, 301 Augustus, Excelsior Springs MO 64024.

TWO INCH TOROID CORES, popular T-200-2. Make balun, fil. choke, tapped tank. PPD $2.75 each, 3 for $7.00. ESELabs, 301 Augustus, Excelsior Springs MO 64024.

"HOSS TRADER ED MOORY": says he will not be undersold on cash deals! Shop around for your best price and then call or write the "HOSS" before you buy! Swan 500C, $449.00: Swan 270 Cygnet, $419.00: Drake T4-XB, $395.00: R4-B, $379.00: TR-4, $559.00: TH6-DXX, $139.95: GT-550, $415.00. New Rohn 50 ft. Foldover tower prepaid, $199.95: New Mosley Classic 33 and Demo Ham-M Rotor, $198.00: New Gonset GSB 201 MklV Linear, 2000 Watts, ($495.00), CASH PRICE $349.00: New Swan 350C, ($420.00), CASH PRICE $329.00: Reconditioned Equipment: L4-B, $549.00: 75A-4, $319.00: and there will be entertainment for all. There will be the customary program of technical discussions, swap and shop, and there will be display tables provided free if you are registered at the lodge.

New Jersey

The South Jersey Radio Association will hold its 22nd annual hamfest on Sunday, September 13th at Molia Farms, off Route 47 at Malaga Lake, Malaga, N.J. 1000–1700 hours, EDST Talk-in and hidden station hunt on 2, 6, and 10 meters. Registration is free but modest fee for prize-drawing tickets. Swap shop, swimming, children's games, snack bar and lots of contacts. Additional detail from Jack Koch K2MZP, 1529 Dogwood Dr., Cherry Hill, N.J. 08034, 609–429–2642.

New York

The annual Syracuse VHF Roundup will be held at the Three Rivers Inn, Route 57, 10 miles north of Syracuse, N.Y., Saturday, October 10. Reservations and information from Charles Sellwood, W2RHQ, 902 1st North Street, Syracuse, New York 13208.

Illinois

The Peoria Area Amateur Radio Club, Inc. will hold it's 13th annual hamfest Sunday, September 20, 1970 at Exposition Gardens (same place as last year), located on the northwest edge of Peoria, Illinois. Lunch will be available. There will be plenty of activities for the entire family, beginning with the campsite opening the preceding evening. Free coffee and donuts from 9:00 to 9:30 a.m. CDT. Free swap section, parking, contests, and cartoons for the kiddies. Advance registration $1.50, ($2 at the gate). For further details and advance registration, write Ferrel Lytle W9DHE, 419 Stonegate Road, Peoria, IL 61614.

Bay Area, this promises to be the biggest hamfest ever.

With the interest that amateurs have displayed in previous years in mind, this year's hamfest will emphasize quality presentations of seminars and exhibits. In 1969 there were more than 1000 amateurs at the hamfest and visiting the exhibits. It is expected that the attendance this year, moving closer to the center of the amateur population in the Bay Area, will surpass this mark.

Illinois

The Chiburban Radio Mobileers announce the 3rd annual 160 meter reunion, Sunday, September 20, 1970 at the Joliet Beach Club, Joliet, Illinois.

There is no admission charge, and no formal activities are planned. The reunion is a chance to get together with other enthusiasts to discuss equipment, operations, noise problems, DX, use of frequencies, etc. Last year's mobile efficiency contest evoked so much discussion that it may be repeated with revised rules. Slides and snapshots of various 160 layouts will be shown.

The Joliet Beach Club is located on Rowell Avenue, immediately adjacent to Interstate Route 80. For those who wish to stay over, there is a Joliet Holidy Inn, and a Howard Johnson motel nearby. Talk-in on 1810 kHz.

Ohio

The 33rd annual STAG hamfest sponsored by the Greater Cincinnati Amateur Radio Association will be held on Sunday, September 27, 1970, at Stricker's Grove on Compton Road, Mt. Healthy, Cincinnati, OH.

The "Cincy" STAG hamfests have grown in popularity each year; last year's attendance was over 2300 hams.



Long-Range Planning for a "Biggie"

If plans continue on course, the next SAROC Las Vegas convention should top all existing ham convention records. Leonard Norman (W7PBV), chairman for the event, says that two charter flights are being negotiated with Chicago- and New York-based airlines. The deal, says Norman, will allow hams near these big cities to come to SAROC at a package price. For less than "normal airline fare," the package will include a champagne flight, transportation to and from the Flamingo Hotel (where SAROC's being staged), tickets to a major stage show, registration and drawing tickets, the annual SAROC breakfast banquest, cocktail parties, seminars, a complimentary casino "free money" packet, and heaven knows what else.

The way things look now, you'll be able to charge the whole thing on your regular credit card (Carte Blanche, American Express, Diners Club, etc.). As far as I can tell, there's just one big hitch: There will be only one charter plane leaving from Chicago and one leaving from New York. Those who make reservations early can be accommodated, but if you wait, you'll end up being left out. To be safe, better drop a card to Leonard Norman now and let him know if you plan to be on either of the two flights. (His address is Box 73, Boulder City NV 89109.)

SAROC is always a big thing for everyone, but this next one should rank particularly high with the FM crowd.

For one thing, both Chicago and New York are FM strongholds, so the number of FM'ers on the flights will probably be disproportionately high. For another, the affair at SAROC will be FM's fourth annual national convention.

The tentative FM schedule so far includes as speakers: Wayne Green of 73 Magazine (and me, of course); Dr. Phil Dater (WA5JDZ), key man behind the chain of interconnected New Mexico repeaters; Art Housholder (K9TRG), general manager of Spectronics, Incorporated; Pat Devlin (K5BPS), from Tulsa Repeater fame; and Gary Hendrickson, renowed author and principal of the Baltimore repeater.

On the regular SAROC agenda (non-FM), the scheduling of speakers is still under way, but I'm sure the lineup will include Wayne Green's slide presentation of his recent visit with King Hussein in Jordan.

At any rate, the Flamingo is making some advance preparations. It has blocked off 600 rooms for the exclusive use of SAROC attendees, who qualify for the special $12 room rate. The advance registration price for those not making the charter flights is $14.50 per person, which includes – among lots of other things – a late show at the Flamingo, a couple of drinks (at Flamingo or Desert Inn), breakfast, cocktail parties, etc.

Repeater Cliques

It's still a little early to call it a trend, but more and more reports are coming in that repeaters are turning "unfriendly." More open repeaters are turning inward, closing to "outsiders"; more member-supported groups are hiking their dues to lock out would-be users.

These are bad signs indeed. Most of the "old salt" FM'ers remember the first couple of years of repeater growth, where the situation was reversed. Repeater owners wanted to encourage as much activity as they could. Then, AM "neighbors," threatened by the big loud band-dominating machines, fought by jamming, boycotting, maligning, and just about every other tactic they could think of.

Repeaters are an accepted part of our way of life, now, but a lot of the "good guys" of yesterday are turning into the "heavies" of today with the techniques some of them are adopting to inhibit further development.

The first step is an innocent one: A club forms for the purpose of providing a means of support for a repeater. The club will usually include a few officers with enough technical talent to keep a repeater percolating and enough members to keep the thing financed adequately.

W 4 B O C

Alford Memorial Radio Club

3271 White's Mill Road
Decatur, Georgia, 30032

July 13, 1970

Dear OM,

Your application for membership was considered at the last regular meeting of the Alford Memorial Radio Club. Unfortunately, no sponsor was present to support your petition and the members present therefore could not act favorably on your application. Should you desire to re-apply for membership at a later time, please be sure a sponsor is present to support your petition. In addition, please include a short sketch of your activities as a Radio Amateur and state the reasons you would like to join this repeater organization.

We will be pleased to reconsider your application at a later time if you so desire.

Yours very truly,

Taylor F. Whitmire, Sect/Treasurer
Alford Memorial Radio Club

A bam in Decatur, Georgia wanted to operate through the local "open" repeater, operated by the Alford Memorial Radio Club. This letter to him from the club secretary speaks for itself.

The next step is the dangerous one: setting up two price lists that serve to factionalize the repeater users. This sets up an "inner group" of a few individuals who think of themselves as an elite caste.

A concerned amateur in one of the biggest cities in Georgia called me recently to tell of a repeater there that will not accept new members. He said transient use of the repeater was discouraged, full membership in the repeater organization was closed, and that operation through the repeater resulted in boycotts or insults. Yet, he said the repeater is referred to (by its management) as being "open," it is set up on nationally accepted channels, and it does not require subaudible continuous tone (PL) for activation.

An amateur in New England called with essentially the same complaint about another repeater. And my letter file includes numerous such reports. It is clear that someone should do something before the situation gets out of hand.

I don't think for a moment that these cases are all one-sided. In some cases, certain individuals are being discouraged because they do not respect the local traditions of repeater use. In others, individuals are discouraged for long-windedness, excessive activation of the repeater, or simply bad operating habits.

However, if the locked-out individuals begin to grow in number; if the repeater takes on the aspect of a "closed" setup; if transients are ignored or discouraged; or if PL is put to use to limit the number of users – then it's time for some giving on the part of the repeater groups.

I have always held that closed repeaters do not belong on national repeater frequencies. A closed repeater on either the .34–94 or .34–.76 pair is an open invitation to unrestricted use by anyone who buys an FM unit. Let the closed repeaters function, but let them function where they do not impose on the rights of others. The simple fact that most ham FM units come equipped with crystals for .34 and .94 makes those frequencies "public," and it is certainly within the rights of a newcoming FM'er to operate using the crystals that came with his rig.

Also, a closed repeater using .34, .76, or .94 prevents the establishment of an open repeater in the area on those channels. The result is that if an open repeater is to evolve, it is forced to happen on a nonstandard frequency pair – the only alternatives being a direct conflict for the national channel or no open repeater at all.

Repeater organizations are necessary, of course, and dues are necessary if the repeater is to be maintained. But all of us should remember that amateur radio is a fraternity traditionally characterized by the "ham spirit." If we let factions and cliques gain a solid foothold in an area as important as FM repeaters, our now-excellent reputation will be threatened in the eyes of the rest of the amateur world. And our image of friendliness and fellowship will decay and crumble.

. . . K6MVH ■

New Subscription Rates?

YOU BET

With this issue of 73 we close out our first ten years of publication. In an era of unprecedented inflation we have done well, we think, to keep our subscription rates as low as we have. We started out at 37¢ a copy, went to 40¢ when the newsstands protested the odd figure, then went to 50¢, 75¢, and finally a dollar. Our subscription rate started at $1 a year, and went to $12 for three years back in 1966.

If congress and the administration would try and cut expenses down we suspect that the inflation would stop. As long as they keep the Bureau of Engraving busy three shifts a day printing more money, we can't have anything except inflation, and (as has been proved rather clearly) curbing consumer credit only makes the situation worse by adding a recession to the inflation.

Suffice it to say, we must inch our subscription rates up a little bit more just to stay in one place. The new subscription rates will take effect with the next published issue of 73, thus giving you time to repent over dawdling on sending in your money.

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AN
EDITORIAL
by
DAVE MANN K2AGZ

Leaky Lines

1 DANIEL LANE, KINNELON NJ 07405

Isn't it time someone did something to relieve the problem of unrestricted use of the entire HF spectrum on such activities as Field Day? The 1970 edition of this annual exercise presented a perfect example of the utter futility of any effort to utilize the bands for any other purpose. From the low CW end to the top of the phone portions of each band there was bedlam. It was just about impossible to get through the crud without being interrupted by FD participants looking for extra contest points.

There is nothing wrong with contests, if you happen to like them, SO LONG AS THEY DO NOT PREEMPT THE ENTIRE AMATEUR SPECTRUM. There seems no logical reason why some portion of each band should not be inviolably secured from contest activity, so that normal use of the bands for standard operation and ordinary ham activity may continue unimpaired.

The ultimate in tactlessness, rudeness, and plain old-fashioned crust was noted when both parties on a phone patch were interrupted and requested for a Field Day contact by some eager beaver in the Fourth District. I would not have believed it possible if I had not heard it myself. The most ridiculous part was, this was an overseas patch to South America, dealing with some missing persons in the earthquake sector of Peru. To say that the operators of the patch were miffed would be the rankest understatement.

Nobody is compelled to participate in any activity he does not fancy. But there has developed a certain breed in recent years, who do not try to understand this. These characters think they have a perfect right to interpose their unwanted presence at will; to ask for reports, audio checks, S-meter readings, opinions about . . . "this microphone I just bought, and what do you think of the quality, Old Man?" This goes on all the time, ad nauseum, without a single thought whether it is right or wrong. That he may be an unwelcome intruder never enters this type's mind, it seems.

And when these people get what they deserve – either total disregard, polite refusal, or an out-and-out reading of the riot act – they feel that they are being sorely put upon. In this scribe's humble view, any imbecile who would interrupt an overseas phone patch to request a contest contact ought to get his head handed to him, or ought to be rewarded with a good, swift kick in his "sitzfleischl."

It would be extremely helpful if certain segments would be declared out of bounds by sponsoring groups of contests, so that participants would understand clearly that any contest activity therein would be proscribed. In the regularly scheduled CD parties, a very small segment of each band is recommended, and to the best of my knowledge, very few noncontesters are inconvenienced by these popular contests. The various other contests which have not yet seen fit to emulate this example could certainly profit by doing so.

* * *

In recent months, on 3997 kHz, a powerful AM station has been operating every evening, starting at 2330 GMT. This is the recently established RSA, the outgoing service of the South African Broadcasting Corporation, in Johannesburg. During the course of their broadcasts, it has been next to impossible to use the adjacent frequencies, due to their big signal. On my receiver they are usually about 30 to 40 dB over S9.

By fortunate happenstance, I happened to hear them playing a recording of one of my songs, and I seized the opportunity to write and thank them for the performance, and incidentally to get in some licks about the interference to amateur operations. They sent me a prompt reply, consisting of a Manila envelope about an inch thick, containing, among other things, their broadcast schedule, times, and frequencies.

There is absolutely no mention of 3997. Their frequencies are announced as 9705, 9695, and 5980. There is no way by which these can be beat together or combined to produce a beat of 3997. However, in a compendium of AM stations of the world, issued by our own government, and available at the Printing Office, the frequency is mentioned as being allocated to RSA.

So I sat down and wrote again. I explained that it would be extremely unlikely that they would garner any sizable group of SWLs on that frequency, since it is occupied solely by amateurs, with whom, unfortunately, they were interfering. Their 250 kW, I added, was being wasted on this particular segment, and might they not reconsider and curtail the use of 3997 in the evenings. I closed the letter with a polite request for further information, if any, and for

(cont. on page 109)

AN INTEGRATED CIRCUIT CW ID GENERATOR

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Seattle WA 98178

A project to develop an automatic, solid-state CW ID generator was recently initiated by members of the Seattle repeater group. Although there have been a number of recent articles concerning such devices,[1-2-3-4] our starting point was the FM Magazine article by Woore.[2] The outcome of this project must be classified as an engineering overkill. The resulting CW identification generator features a clocked character generator (for flawless CW with variable speed), inexpensive RTL integrated circuitry, and a computer-designed diode read-only memory matrix. Also included are "pulse" starting, a discrete "hold" voltage available during ID execution, and a continuously adjustable keying speed (from far too slow to far too fast). Not only are these generators ideal for repeater identification, but they may be used to identify any amateur station such as RTTY, ATV, etc.

The block diagram in Fig. 1 shows the major divisions of the ID generator. Many excellent articles covering RTL logic design

have appeared in amateur literature[5-6] and the reader is referred to them for background material.

Program Counter and Start/Stop Flip-Flop

This six-stage ripple counter consists of three dual JK flip-flips. The first five cascaded stages are the program counter and count from 0 to 31. The last stage is employed as the start/stop flip-flop. Each stage of a ripple counter is arranged to toggle (change state) on the output of the preceding stage. A five-stage program counter has 32 distinct stages (2^5=32). (number 32) resets or clears the first five stages, but toggles the start/stop flip-flop to the "stop" or set position, thereby halting the character generator.

A positive pulse into the "preclear" input of FF6 clears the halt and allows the character generator to run, thereby initiating a cycle of operation. A five-stage program counter was chosen since virtually all amateur calls can be encoded in 32 characters worth of dots, dashes, and blanks. RTL JK flip-flops are adversely affected by capacitive output loads, and

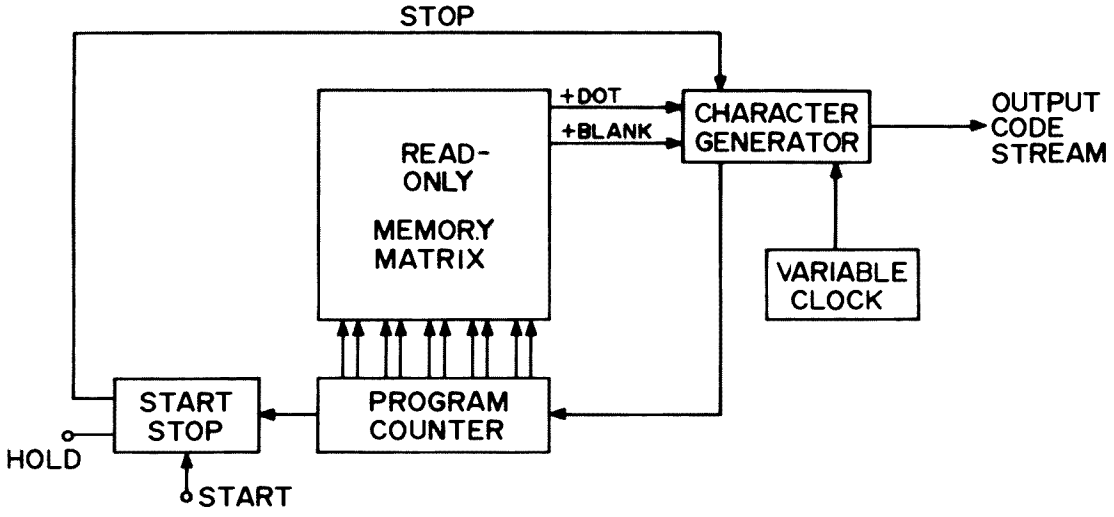


Fig. 1. CW ID generator block diagram.

When arranged as shown in Fig. 2, the program counter advances under the control of gate G1 which derives its input from the character generator. Each dot, dash, or blank character advances the program counter by one count. The last character will not toggle reliably if the capacitance is too high. This fact precludes the use of silicon diodes in the *and* portion of the diode memory.

If the program counter output lines were buffered (isolated from the flip-flops

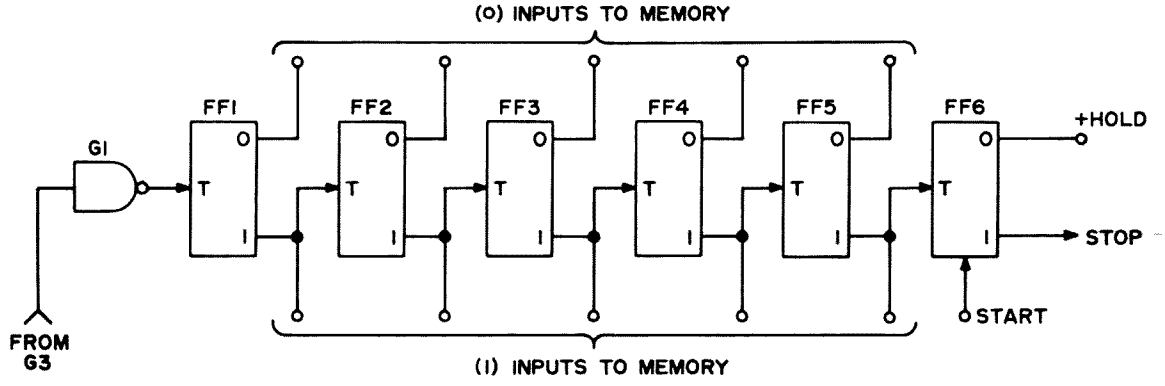


Fig. 2. Program counter.

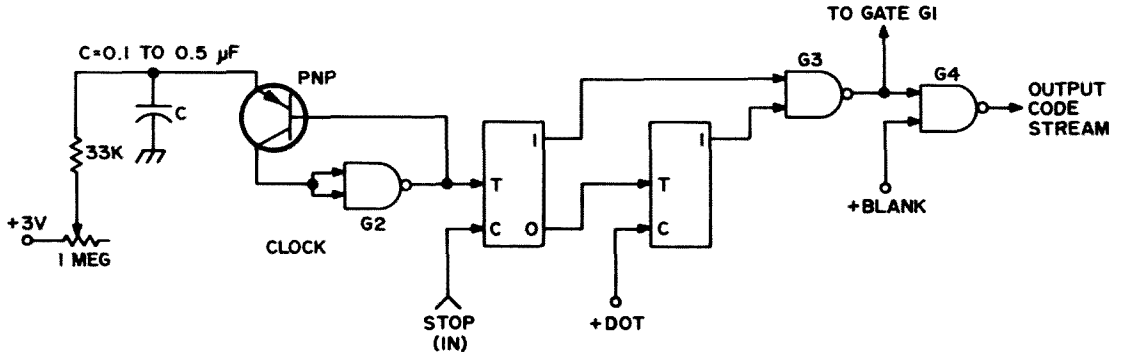


Fig. 3. Clock and character generator.

with gates or inverters), then any type of diode could be used in any memory position; but germanium diodes have very low capacitance and may be connected directly to the flip-flop outputs, thereby saving the cost of 10 buffer stages.

Variable Speed Clock

The clock circuit must deliver a negative-going pulse with leading edge of less than a microsecond duration in order to toggle an RTL JK flip-flop. The pulse repetition rate should be variable to permit choice of code speed. The circuit is shown in Fig. 3 with a PNP silicon transistor paired with gate G2. The net effect is a PNPN switch. Capacitor C charges to about 2V and then discharges through the gate with a leading edge which is very abrupt.

Nearly any of the new PNP silicon transistors will work in this circuit. The minimum value for R is about 33 kΩ else sufficient current is available to hold the switch in conduction (just like a neon relaxation oscillator). For R much above 1 MΩ insufficient current is available to initiate the regenerative "snap" action. Values of R between these limits work well.

Character Generator

The electronic generation of Morse code requires the creation of dots, spaces, dashes, and blanks which have a precisely specified relative length. The dot and space are each of one unit duration, while the dash and blank are each of three units duration.

An extremely clever character generator was borrowed from the Micro-Ultimatic Keyer[7] and forms the heart of the ID generator. The character generator consists of two JK flip-flops (FF7 and FF8) and gates G3 and G4 as shown in Fig. 3. A positive (stop) voltage on terminal C of FF7 holds it in the clear state, thereby stopping the character generator. If the stop voltage is removed, the character generator toggles in such a manner as to produce a string of dashes at the output of gate G4. If a positive (+DOT) voltage on terminal C of FF8 changes the string of dashes into a string of dots. A dash (or blank) requires four clock pulse intervals while a dot requires two. Gates G1 and G4 each invert the output of gate G3.

The output of gate G1 must be either a dot or dash character (never a blank), and is used to advance the program counter at the end of each character. The second input to gate G4 will blank out the output code stream, and is used to produce a blank character. If a blank is required, then a positive "+BLANK" input from the diode memory causes the dash generated by the character generator to be blanked

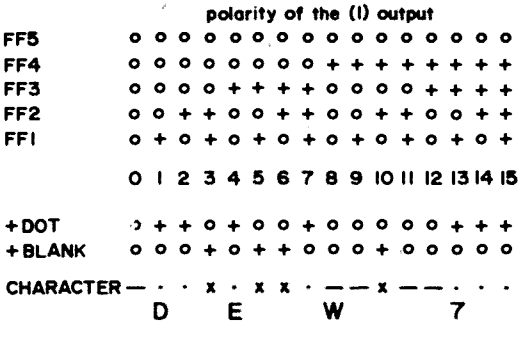


Fig. 4. Diode memory inputs and outputs.

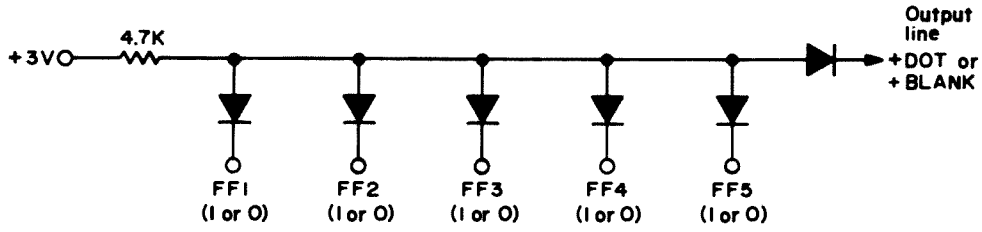


Fig. 5. Diode decoder for program counter.

out – which results in the transmission of a blank character.

Thus, the role of the diode read-only memory matrix is to provide just that sequence of +DOT and +BLANK inputs to the character generator which results in the transmission of the desired code stream. Gate G4 is the output with a plus representing "key down" and a zero representing "key up."

Diode Read-Only Memory Matrix

This is the hard part! Each desired code stream requires a distinct and different read-only memory design. A +DOT voltage must be produced by the diode memory for each program counter state that corresponds to a dot in the desired code stream, and a +BLANK is required for each blank character. An example is presented in Fig. 4.

i.e. if neither a +DOT nor a +BLANK occurs, a dash results. Each of the 32 program counter states must be accounted for since they all appear on each ID execute cycle.

Figure 5 shows the method for decoding the program counter. The five terminals marked FF1 through FF5 are connected to either the **1** or **0** side of the respective flip-flop. If *any* of the five connections is low, then the whole common line is low. The only time the common line can be high is when all five input connections are high. For any given connection, this will occur exactly once during each program counter cycle. This type of diode decoder is often called an *and* gate since it has a high output only when all inputs are high.

Because of the diode output from the common line, these decoders may be paralleled to obtain the required +DOT and

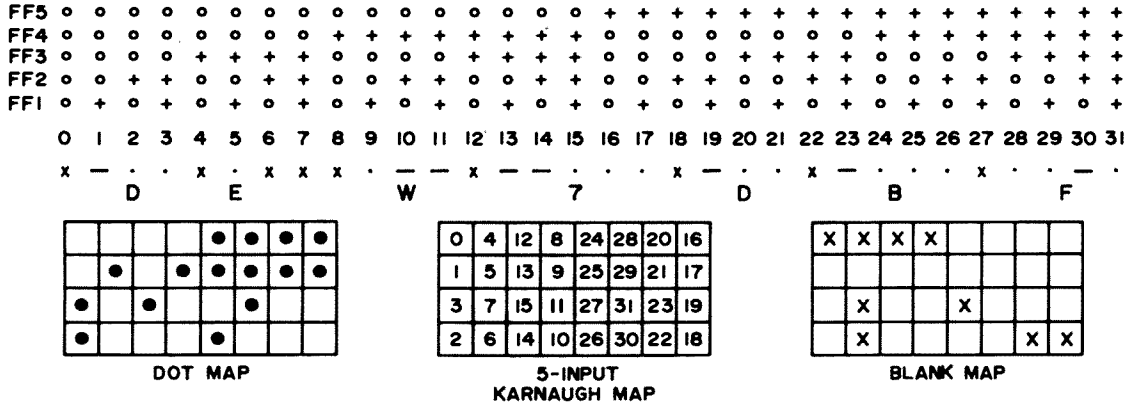


Fig. 6. Using the Karnaugh map.

Suppose that the first letters of the desired code stream were "DE (blank, blank)W7". The program counter states are shown corresponding to the required outputs from the diode memory matrix. A dash is seen to be the "default" condition; +BLANK functions. This paralleling is often referred to as an *or* gate since *any* high input results in a high output.

In the example of Fig. 6, the desired code stream has 15 dots and 9 blanks. If we employ a separate diode decoder for

each one, then a total of 24 decoders would be required: 15 would be paralleled to give the +DOT signal and the remaining 9 would be paralleled to provide the +BLANK signal. Each decoder requires 6 diodes for a grand total of 144 diodes to build a straightforward read-only memory using this technique.

Fortunately for us, the English philosopher George Boole published his *Investigation of the Laws of Thought*, in which he resolved the ambiguity of the words *and* and *or* by means of a kind of algebra. In 1938, eighty-four years later, Prof. D. E. Shannon (the *Information Theory Shannon*) put Boole's algebra or Boolean Algebra to use in the *Symbolic Analysis of Relay and Switching Circuits*. This classic paper has revolutionized switching design, and has led to the development of minimization techniques which can dramatically reduce the diode count of our ready-only memory. The details of these methods and the underlying theory are beyond the scope of this article, but for those who are fascinated by this stuff, standard texts are available which will quickly dispel the aura of "black magic" that seems to surround this area.[8]

For our purpose, a graphical reduction technique known as a *Karnaugh map* will be employed. Figure 6 illustrates the process for the code stream *DE W7DBF*. The polarity of the **1** output levels of flip-flops FF1 through FF5 are shown as the program counter steps from **0** (all FFs clear) to state 31 (all FFs set). The sample code stream begins with a blank and has three blanks separating the **DE** from the **W**

A Karnaugh map organization of program counter states is presented, flanked on the left by the DOT map and on the right by the BLANK map for the desired code stream. Reduction is accomplished by "folding" the map about any of the dividing lines and pairing the marks (dots or blanks) which overlap. For example, folding the DOT map about the vertical centerline pairs dot 5 with dot 21, and dot 9 with dot 25, and dot 15 with dot 31.

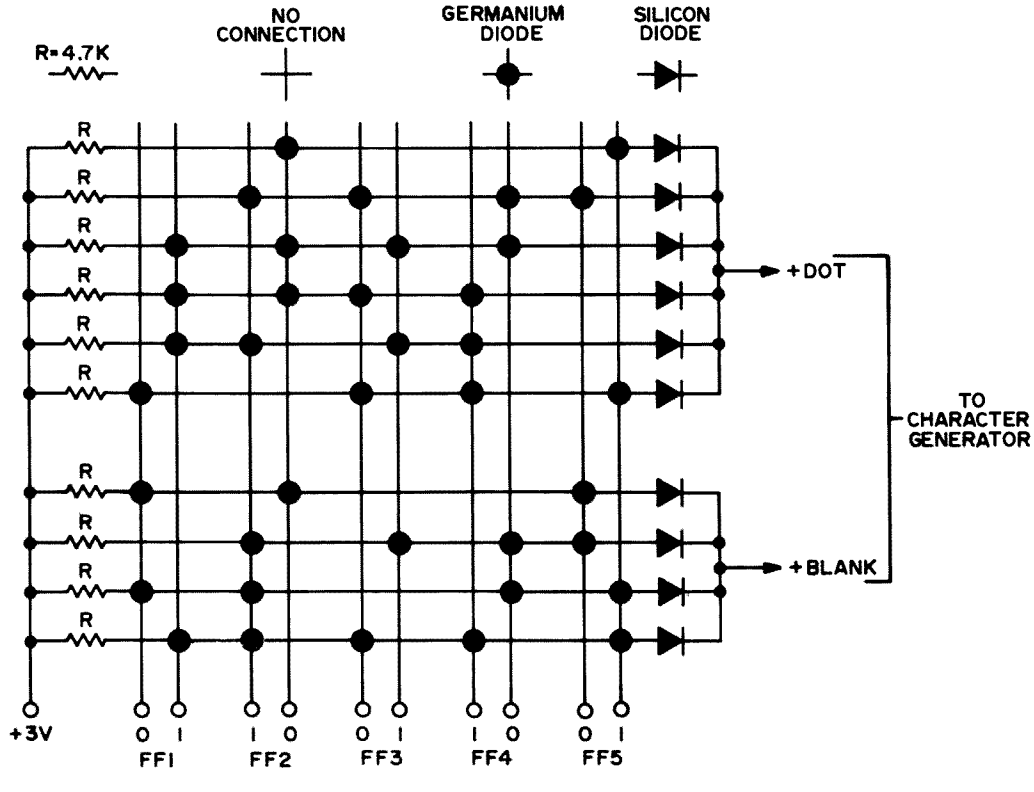


Fig. 7. Diode read-only memory matrix for "DE W7DBF."

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Successive pairing, then pairing pairs, etc. allows a reduction from the original 144 diodes to a total of 48 diodes arranged as shown in Fig. 7. Note that in Fig. 7, the **0/1** flip-flop lines are reversed for FF2 and

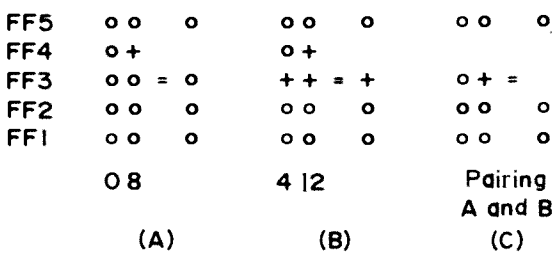


Fig. 8. Actual reduction procedure.

FF4. This reversal materially simplifies printed circuit construction.

As an example of pairing, consider the blanks in positions 0, 4, 8, and 12 of the BLANK map of Fig. 6. If the map is folded about the second vertical line (the one separating positions 4 and 12), then blank 4 pairs with blank 12, and blank 0 pairs with blank 8. If we fold again, then all four blanks coincide

is illustrated in Fig. 8. In part A, the program counter states for positions 0 and 8 are compared. They differ in exactly one FF position (FF4) as all pairs must. A single diode decoder of the type shown in Fig. 5 could get both blanks simply by neglecting to connect to FF4. It even saves one *and* diode.

Part B of Fig. 8 presents the same comparison for blank 4 and blank 12, and again they differ only in FF4. In part C, a comparison of the 0/8 with the 4/12 pairs shows that these differ only in FF3. Thus, if a three-input diode decoder of the type presented in Fig. 5 were connected to FF1 (**0**), FF2 (**0**), and FF5 (**0**), it would give a +BLANK for all four desired program counter states (0, 4, 8, and 12). Without this reduction, 24 diodes (six for each blank) would have been required rather than the four actually required. This diode decoder may be found in Fig. 7 as the first line in the +BLANK group.

The foregoing example illustrates the use of a Karnaugh map. The states which

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map, and then the actual reduction is performed as in Fig. 8. It should be noted that some states will not pair at all, such as blank 27 in Fig. 6. To pick up this blank, a full five-input diode decoder is required. From Fig. 6, we see that for blank 27, the program counter is in state "++0++" and the resulting diode decoder can be found in Fig. 7 as the bottom diode line.

The rule when pairing states is that the two program counter states can differ in exactly one flip-flop position. All other positions must agree, including any omitted connections as in Fig. 8, part C. If there is disagreement in more than one FF position, then these two states do not pair.

After completing the reduction process, check to make sure that every necessary state has been covered at least once by one of the final decoders; otherwise, you may be surprised at the resulting code stream. This type of calculation, once understood, is not particularly difficult, but it certainly is tedious and has lots of room for errors. Slight changes in the desired code stream (even position) can have a huge impact on the diode count.

For example, the diode count for the code stream in Fig. 6 is 48. If just the *DE* is slid one count to the right, a new code stream is formed which starts with two blanks, and has two blanks between the *DE* and *W*. The diode count for this new stream is 55. If this new stream is shifted two positions to the left, so that the two leading blanks become trailing blanks, then the diode count becomes 85. These effects are unpredictable, and for complete optimization each code-stream version must be reduced separately, and the results compared. This greatly increases the already great tedium of such calculations.

Computer Optimization

In order to minimize the pain of diode memory design, the task was subcontracted to a digital computer. The Seattle repeater group is extremely fortunate in having remote access to the University of Washington Computer Center's Burroughs B5500 computer, one of the nicest hardware/software systems ever put together. The resulting program in extended ALGOL accepts the desired code stream (in dots, dashes and blanks) as an input and performs a complete Boolean reduction for both +DOT and +BLANK diode decoders.

If the specified code stream is less than 32 characters (more than 32 characters are not allowed), then the computer assigns the necessary trailing blanks and performs

```
EXECUTION BEGINS...


CODE STREAM [ -.. .   .-- --... -.. -... ..-.]
REQUIRES 48 DIODES AND 10 RESISTORS.

PLACE SILICON DIODES (S), GERMANIUM DIODES (G), AND
4.7K RESISTORS (R) IN THE FOLLOWING POSITIONS:

 D B  0 1 2 3 4 5 6 7 8 9  +
 S          G              G  R
 S        G   G      G G    R
 S      G   G   G   G        R
 S      G   G G   G          R
 S      G G     G G          R
 S    G       G   G      G   R
   S  G     G           G    R
   S      G     G   G G    R
   S      G           G   G  R
   S    G G   G   G     G  R

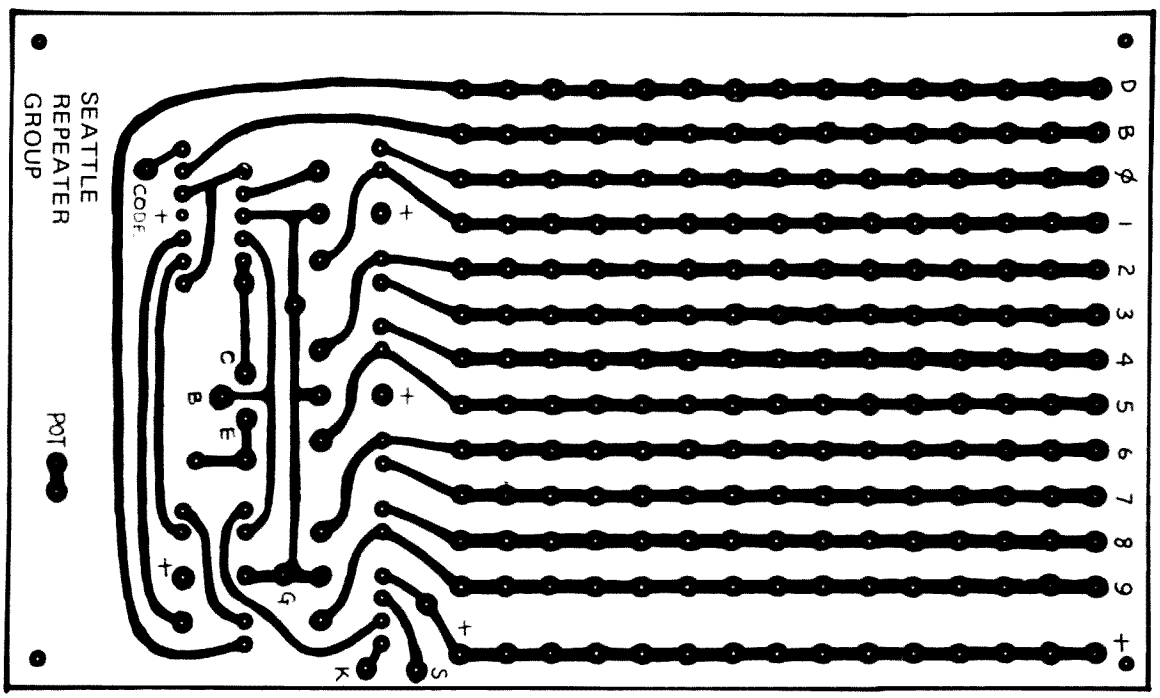

EXECUTION COMPLETE...
```

Fig. 9. Computer printout.

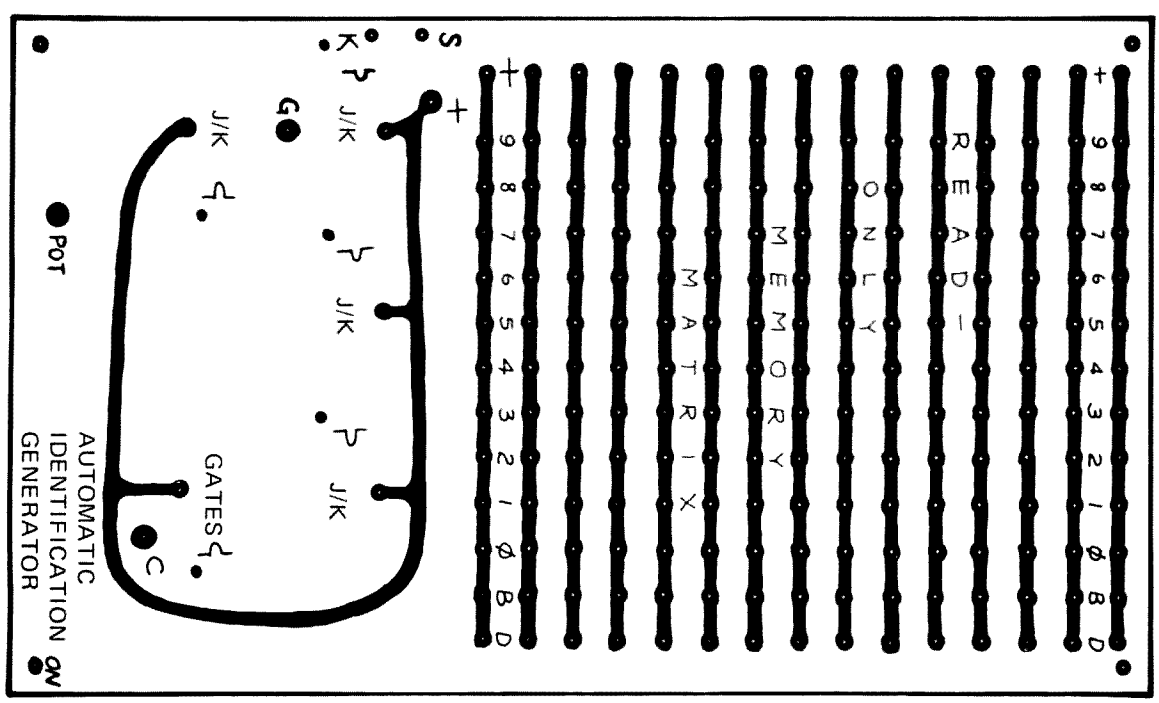
the required reductions, and repeats the process for each shift of the code stream until all the trailing blanks have become leading blanks. The code stream version having the smallest diode count is printed out along with diode and resistor counts and an actual map of the entire diode read-only memory matrix. Examples of the digital computer printout are shown in Fig. 9.

Construction

The four dual JK flip-flops are Motorola MC790P (or HEP 572) and the quad 2-input gate is a Motorola MC724P (or HEP 570). Virtually any PNP silicon tran-



Circuit board (bottom).



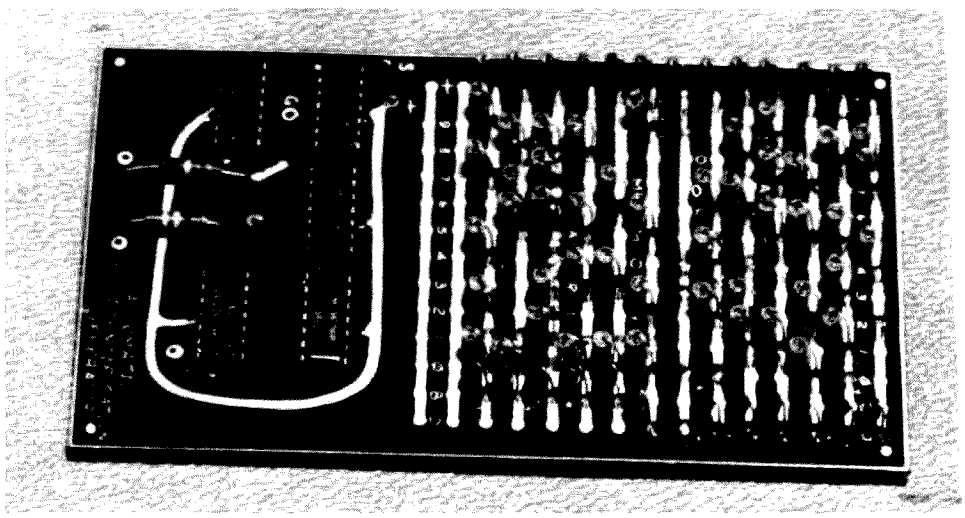
Circuit board (top).

Fig. 10. Full-size reproductions of PC board.

sistors will function in the clock circuit. A HEP 57 is a good choice. Both germanium and silicon diodes are used in the diode read-only memory. Germanium diodes are employed for the *and* function, since their low junction capacitance will not load the JK flip-flops in the program counter. Either silicon or germanium diodes may be used in the *or* function, with silicon signal diodes preferred since they result in a higher noise margin for the memory. Cheap diodes are available from various solid-state supply houses. Poly Paks features 50 silicon or germanium diodes for $1.

Both sides of 3 x 5 in. double-sided PC board are shown in Fig. 10. A one-sided board was used for the first few models, with a second 3 x 3 in. board used to complete the matrix connections. This "cordwood" construction is a pleasure to look at, but a nightmare to wire up. If a diode goes "west" on a cordwood style generator, it is best to throw it away, since unsoldering about 80 diodes and resistors and then getting things back together is even worse than the initial construction effort. A double-sided epoxy–glass PC board is recommended for the ID generator. An operational generator should be enclosed in a metal box with all leads bypassed for rf. Even VHF/UHF fields have the ability to drive RTL logic circuitry absolutely crazy. Before undertaking the construction of this ID generator, the builder should obtain as many of the referenced ID generator articles[1-2-3-4] as can be found and read them over carefully. The additional background material will amply repay the effort involved.

The Seattle repeater group can supply a moderate number of tinned epoxy–glass circuit boards for this ID generator. The board is not drilled, but assembly instructions and a computer optimized diode map for the circuit board is included. Be certain to specify the desired code stream, keeping in mind the absolute limit of 32 characters (dots, dashes, and blanks). Unit cost is $10, and they may be obtained from the Seattle repeater group, 18235 46th Pl. S., Seattle WA 98188.



Here's what the board looks like when the flatpacks and diode matrix are soldered in. The vertical placement of the diodes helps to keep the size down to this 3 x 5 in. circuit board.

Acknowledgement. The author expresses appreciation to K7EVO for art photography, and to K7MWC for the snapshot.

References

1. *A Digital Identification Generator,* Barry Todd K6ZCE, 73 Magazine, March 1967.
2. *IC Repeater Identifier,* Tom Woore WB6BFM, FM Magazine, January 1969.
3. *Automatic CW Identifier* John Connors W6AYZ, Ham Radio Magazine, April 1969.
4. *A Digital Morse Code Generator,* Jerry Hall K1PLP, QST, June 1969.
5. *Digital Logic Devices,* QST, July 1968.
6. *Micro-Logic for Non-logic Users,* Hank Olson W6GXN, 73 Magazine, June 1967.
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. . . W7PUG ■



6 volts from 12 volts the Easy way

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118 Waupelani Drive
State College PA

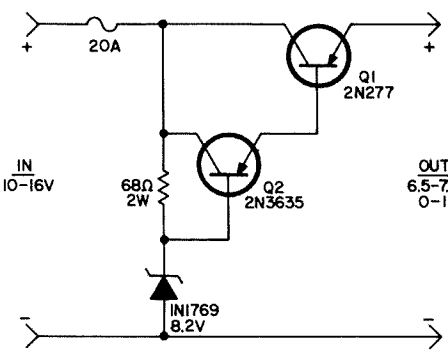
Mobile gear designed for 6V batteries is often sold at a bargain price simply because 6V electrical systems are not as common as they once were. I recently bought a 6V transceiver suitable for 2 meters FM. At the time, I had visions of doing a little tinkering to change the internal supply to 12V. Unfortunately, the internal supply turned out to be almost as complicated as the rest of the transceiver. Instead of a little tinkering it was going to be a lot of hard work. One possible alternative was to somehow get 6V from my car's 12V electrical system.

The classic method of using a dropping resistor wouldn't work in this case. Like most transceivers this one required almost ten times as much current while transmitting as it did when receiving. With a dropping resistor this meant providing the proper current and voltage while receiving, then upping the source so I still got 6V when I tried to draw ten times as much current for transmitting.

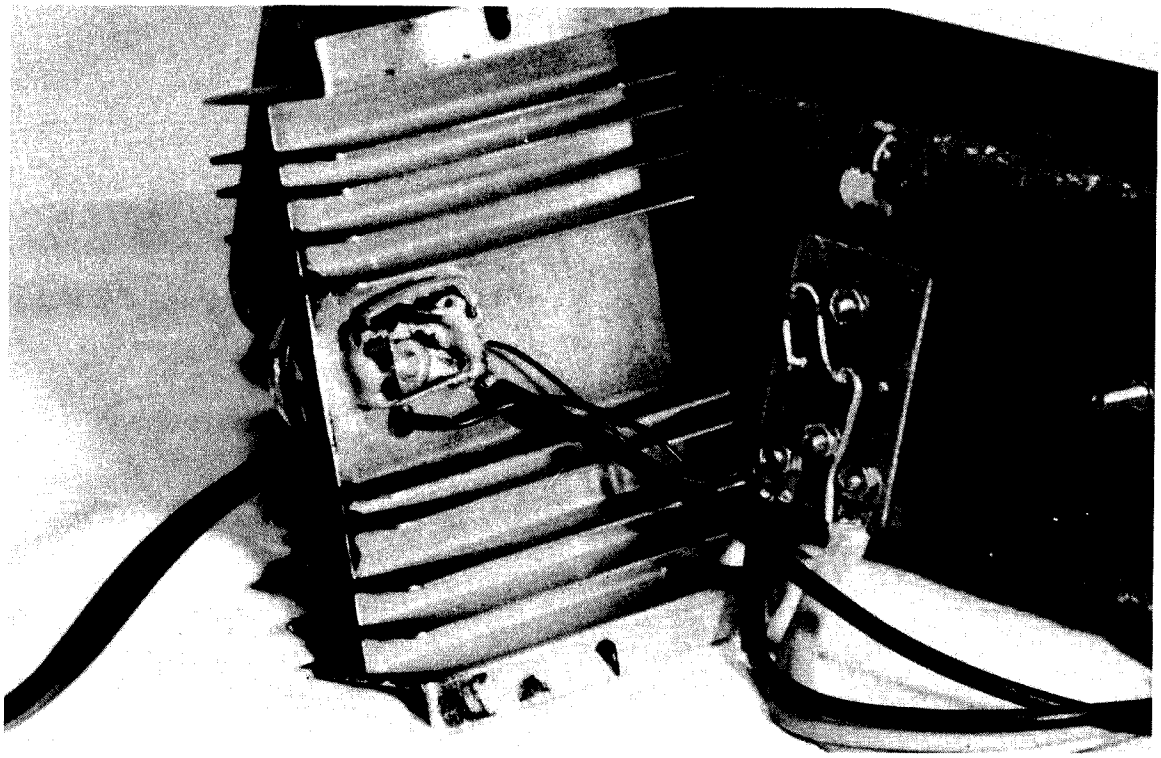
The solution was to build a device that would deliver a constant voltage under all conditions. This device would also have to handle currents of from 1 to 15A and yet be cheap enough to make buying 6V gear still seem attractive. A little investigation pointed to a solid-state regulator as probably the best answer. True, it would be as inefficient as a dropping resistor power-wise, but for my purpose, simplicity and low cost were more important than power efficiency. So with these requirements in mind I came up with the circuit shown in Fig. 1. It worked so well that I thought others with 6V gear and 12V vehicles would like to try it.

Operation

When I switch from transmit to receive, the current to my transceiver jumps from 1.5 to 12A. As this happens, the current to the base of Q1 changes from a few microamps to only a few milliamps due to the current gain of the transistors. The base current for Q1 is drawn from a point at 8.2V; voltage is produced by a zener diode and a 68Ω resistor. The zener diode maintains essentially the same voltage when the current through it changes. So with about 100 mA flowing through the diode, little



happens to the 8.2V when a few milliamps are diverted from the diode to the base of Q1. Q1 and Q2 have only current gain and no voltage gain due to the way they're connected. This means that the 8.2V of the zener appears across the load. Actually, there is a small voltage drop through each



Inside view of the regulator. All components except a zener diode are epoxied to the heatsink. The small fiber glass board holds the zener and acts as a strain relief for the heavy wires.

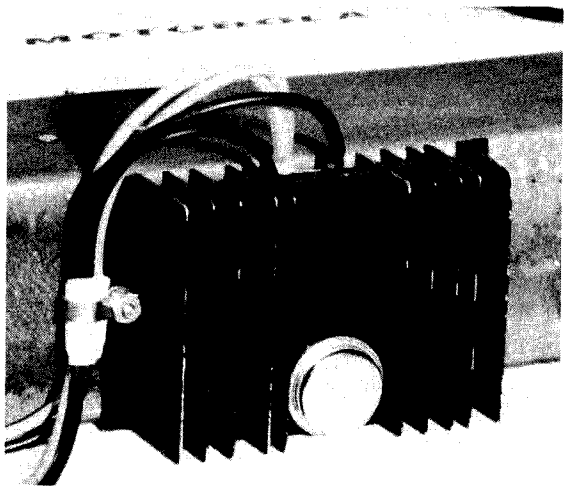
transistor, and the voltage to the transceiver is about 6.5V.

Parts and Construction

When I first began collecting parts from my regulator I bought a bargain power transistor and a heatsink from a mail order surplus dealer. The rest of the parts I scrounged from my junkbox. Unfortunately, a 2N3635 happened to be the only transistor I had on hand with the right characteristic to drive the power transistor. I say "unfortunately" because a 2N3635 carries a rather high price. Luckily, there's a large group of cheap transistors (2N2147, 2N4314, 2N3613) that will work as well. If you don't use a 2N3536 you'll find that the regulator parts are low cost, easily found items. You can buy everything necessary from any large electronic distributor at a cost of about $6 or less.

The parts you end up with and the space available will determine the exact layout. Placement of parts is not critical, but try to put the regulator in a spot where heat will not be trapped. For best heat removal, mount the regulator on a large metal surface, with the heatsink fins open to the air.

I mounted mine on the back of my transceiver as shown in the photo. This allowed the chassis to carry away most of



Top view of the regulator showing input and output lines. All other circuitry is located under the heatsink.

the excess heat. The 2N3635 and the 2W resistor normally run warm, too, so I epoxied both to the underside of the heatsink. To hold the zener and serve as a strain relief for the heavy wiring, I made a small fiberboard card. The card fit nicely

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under the center section of the heatsink despite having some of the space taken up by the epoxied parts. From the card I ran 14 AWG stranded wire through a 20A fuse to a plug designed to fit a cigar-lighter socket. With everything except the fuse enclosed by or mounted on the heatsink, the regulator proved to be both compact and rugged.

Checkout and Alignment

When the regulator is completed it will require some simple tests before it's ready for operation. Carefully check all the wiring before connecting it to a 12V supply. Because of the high current involved, a wiring mistake could be dangerous. As a check on the output voltage, connect about a 10Ω 10W resistor to the output and a 12V supply (or car battery) to the input. Measure the voltage across the 10Ω resistor (should be about 7.5V). This will be the output voltage under light load. When the current drain is raised to 15A, the voltage will drop by about a volt. The drop is usually all right since most 6V gear will work from a 6–8V supply. If you feel that the output voltage is too high for your application, change the 8.2V zener diode to a 7.5V diode. This will drop the output voltage by 0.7V.

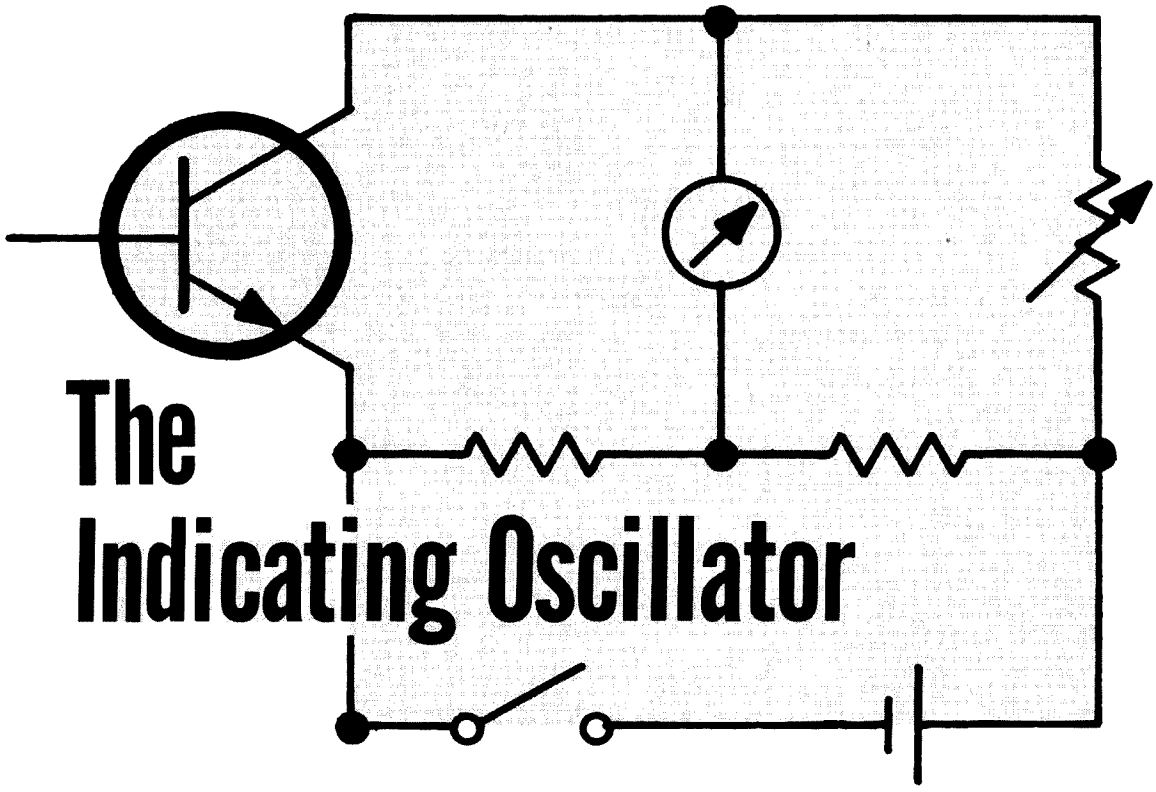
Comments

Once testing and alignment are completed, the regulator should be in good working order. The output voltage will stay almost constant even if the supply voltage goes as low as 10V or as high as 16V. And currents of 1–15A can be drawn with only a small change in output voltage. I don't recommend applying more than 16V to the regulator or drawing more than 15A through it; such conditions exceed the ratings of the power transistor. Also, don't try to draw maximum current continuously if your heatsink is not capable of dissipating at least 150W. If you don't intend to draw high current or you draw high current intermittently, a smaller heatsink can be used.

Author's note: Thanks to Nevin Davis, Pine Groves Mills, PA, for the photos used in this article.

. . . K3GSY ■

Ken Brown KH6AF
Box 1573
Hilo HI



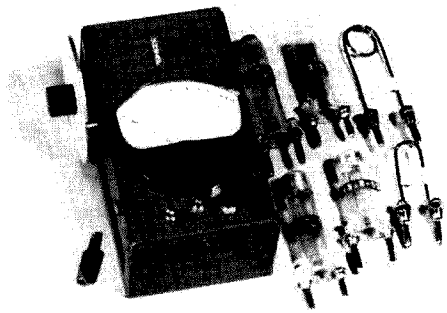
The Indicating Oscillator

Relatives of this little gadget have been around a long time! Even the transistorized versions, which usually leave something to be desired. With an FET, however, we are back in business as with tubes, but with many advantages.

The range of this oscillator is fantastic. That is, without any circuit tricks or special handling. The low frequency end was carried down to the 1 MHz in order to cover the lowest ham band. The high end takes care of 250 MHz easily. This can be extended with a little more effort.

Use of a field-effect transistor (FET) allows operation more nearly like the tubes with which we are, perhaps, more familiar. However, we are not tied to the power lines, which alone makes it worthwhile.

A 2N4221 FET was used in this indicating oscillator. Very likely other FETs will work also. The MOSFETs also should be as good, if not better. The new ones with built-in diode protection would be much easier to handle.



Standard banana plugs spaced ¾ in. make ideal bases for the coils. The lower frequency coils are wound on polystyrene forms.

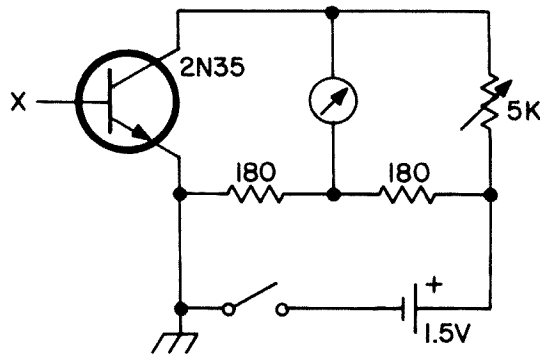


Fig. 1. Indicating oscillator circuit diagram.

The circuit (Fig.1) is not critical. However, the sensitivity control should not be bypassed. Layout could possibly be improved with a slightly larger box, allowing the dial to be placed on the face with the meter. It is a good idea to keep the layout symmetrical as far as possible, particularly the tuned circuit. This can be seen in the photo of the inside view. The box used was an LMB 532 EL with the cover reversed to allow for coil mounting insulator (polystryrene or other good rf insulating material). The meter should be a 50 μA movement; otherwise, a meter amplifier such as the one shown schematically in Fig. 2 will be necessary. This is no problem, as there is room for this amplifier on the circuit board.

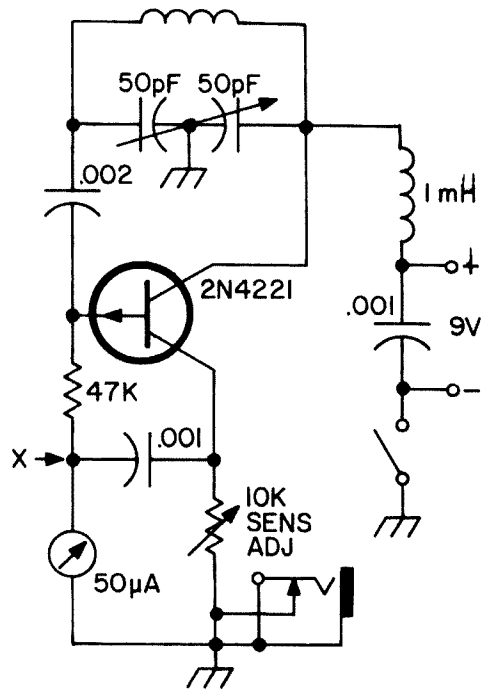


Fig. 2. This meter amplifier will increase the level of the signal so that a less-sensitive meter than 50 μA may be used.

A thumbwheel from a BC-375 tuning unit could be used very nicely as a dial. Three sides have been left clear for ease in placement of unit when in use. Plug-in coils makes for easy bank change and application to the job at hand. Standard-spaced banana pins allow for use with other accessories. Use 5/8 in. polystryrene tubing and stud-type banana pins.

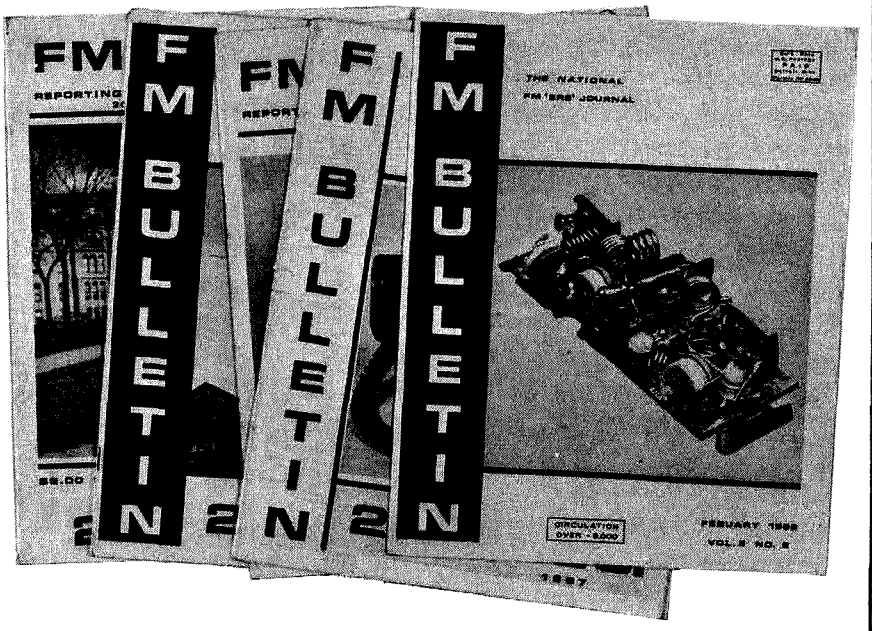
A dual banana plug can be used during construction for setting the spacing accurately. The coils shown have the pins wired in place for stronger mechanical assembly. Drill a hole for about 24 AWG copper wire on each side of the pin studs which will lie along each side of the poly tubing. Use a number 59 or 60 drill. One wire is enough on each pin. Form a hairpin with about an inch of wire, push it through the drilled holes from the outside. Now twist tightly with longnose pliers, cut it off short, but not so short as to allow the wire to untwist! Then apply several coats of liquid "poly" cement. Be sure to move the coils frequently during the hardening period to make sure the liquid "poly" flows evenly over the stud and forms a slight fillet with the tube. Epoxy doesn't seem to work well with polystyrene. Neither Allied nor Newark list liquid polystyrene any longer, but your neighborhood hobby shop should be well stocked.

The lowest frequency coil (number 1, 0.95–2.2 MHz) was made from a Miller 951 ferrite 0.5 mH choke with 6 or 8 turns removed – just enough to slip inside the poly tubing. Some reaming may be necessary. The number 2 coil (2.2–5.4 MHz) was made from a Miller ferrite antenna unit with the slug permanently installed in the top end and all lugs and mounting hardware removed. This coil was also mounted inside the poly tubing. The number 3 coil (5.4–13.5 MHz) consists of 32 turns of 28 AWG enameled wire, close-wound on the outside of the poly tubing. All coils are 2½

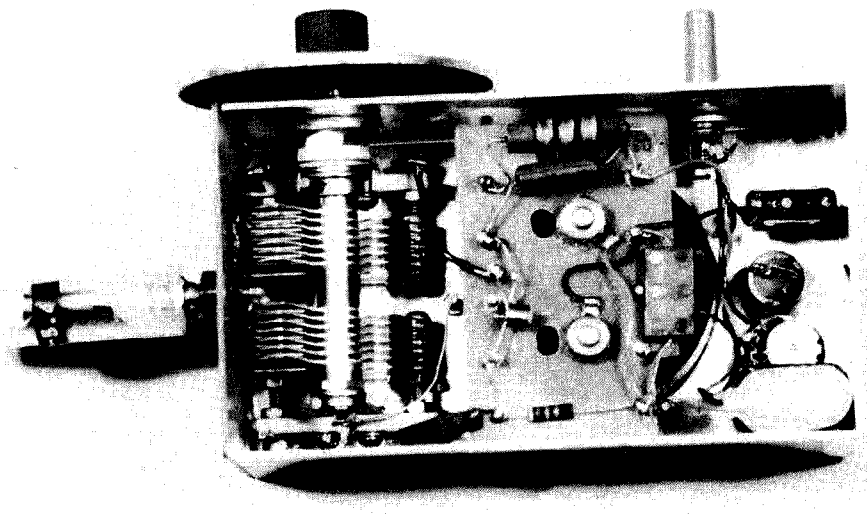
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Interior view of oscillator with coil attached shows construction of the author's version.

in. long with windings as near the end as practical. The number 4 coil (27–50 MHz) consists of 10 turns of 24 AWG enameled wire, close-wound. The number 5 coil (45–100 MHz) consists of 2 turns of 14 AWG enameled wire, self-supporting. The number 6 coil (60–270 MHz) is one hairpin loop 3/8 x 1 in.

A jack is provided for headphone use. The screwdriver-adjusted miniature pot is for zero adjustment of the meter amplifier. It can be seen in the photograph.

. . . KH6AF ■

Bill Hoisington K1CLL
Far Over Farm
Peterborough, N.H.

LOW AND INFINITE ATTENUATOR FOR TUNING VHF RECEIVERS

One of the most useful test-equipment gadgets the homebrewer can build is a signal generator. The one described here is of commercial quality and it can be completely contained inside a waveguide. Positioning, by sliding along the waveguide, provides a variable-strength stable signal of one millivolt, one microvolt, one nanovolt, or less, dropping down gradually to a true zero. It does this in a perfectly smooth fashion without steps or jumps so that every fraction of a decibel in lower noise figure shows immediately on the slide dial. What's more, the slide can be calibrated so that FM'ers can use the device for directly measuring receiver sensitivity in tenths of a microvolt.

In building a 6 meter receiver recently for maximum absolute sensitivity I naturally had to check especially on the first-stage rf transistor and circuit for minimum noise figure. (For this type of work you *must* have a signal generator capable of being attenuated out of sight with any receiver you can buy før any money.) The usual generators on the market under $100 do not do this. And many of the very expensive generators get so leaky that they have to be used 200 ft from the receiver. At any rate, the generator described here can be made up quickly and at low cost, and it *is* stable, reliable, and infinitely variable.

Waveguide

The only possible difficulty might be in obtaining the piece of waveguide needed. The piece I used is 4¼ in. wide by 2 1/8 in. high, and is 24 in. long. If you have a choice, get a piece a little longer. You could make up this item out of brass or copper if you had to, because in this case it is not used to *carry* energy but to *attenuate* it, so the worse you make it the better!

The waveguide *must not* have any holes in it and should be reasonably smooth inside; otherwise your dial would not read smoothly in attenuation. You *could* use copper or aluminum drain pipe, although I have not tried them yet. Working directly on the rf, this attenuator is good for any kind of modulation, including SSB, FM, pulse, or what have you.

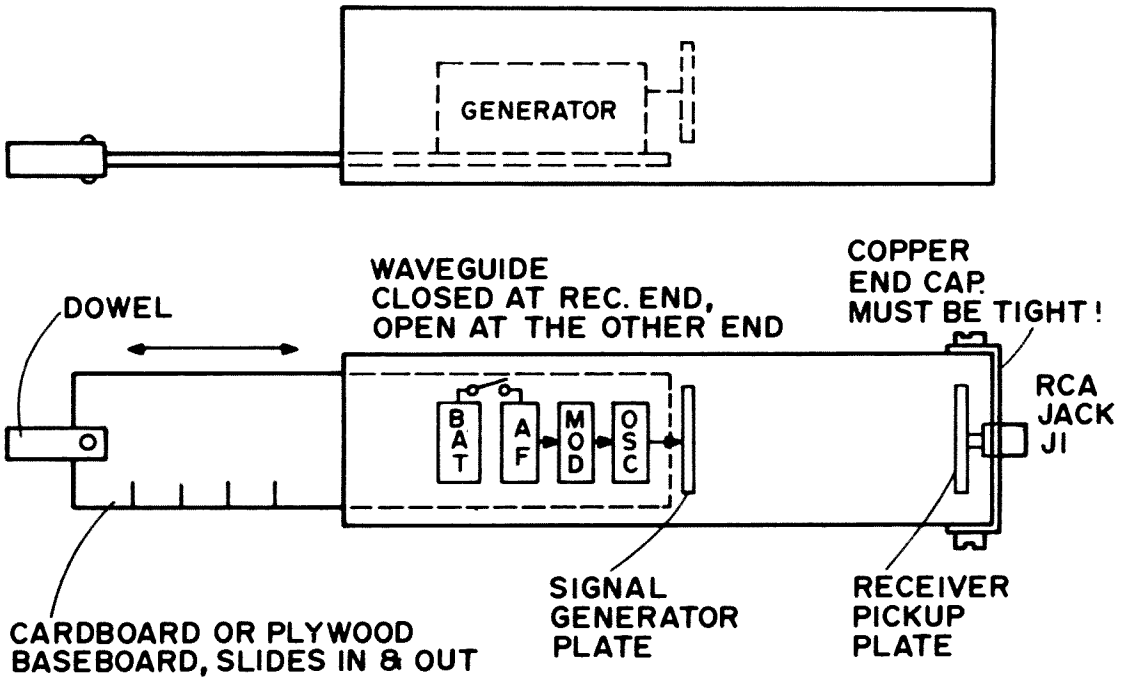


Fig. 1. Sketch shows plan-view layout of unit inside waveguide attenuator. The oscillator unit is mounted on a flat wood or cardboard strip that can be calibrated to give accurate indications of output signal.

Construction

Figure 1 shows the basic idea. When the signal generator plate is close to the receiver pickup plate, you can get about 100 mV of signal into the receiver, and it is handy for checking diode receivers. When the two plates are about 8 in. apart, the signal is just detectable on a good receiver. Additional spacing between plates amounts to "waveguide beyond cutoff." I do not believe that there is any receiver in the world that can pick up the signal much beyond the 8¾ in. point.

Pretty soon in your receiver "peaking" work you get to that signal that may be but a tenth of a microvolt or so, and you begin dreaming about cryogenic front ends, masers, and such. As mentioned, every fraction of a decibel lower in noise figure, every improvement in sensitivity comes out rigorously and relentlessly on that slide dial. You can easily check which of your low-noise transistors is really low, whether that MOSFET will do a better or worse job for you, and in which circuit.

As you go up in frequency you may have to make smaller and smaller oscillators in order to fit in smaller waveguides to get the cutoff effect. (That will not be a problem if you read 73; the May issue described a "postage-stamp-sized" rf generator that is an ideal candidate for the signal source.)

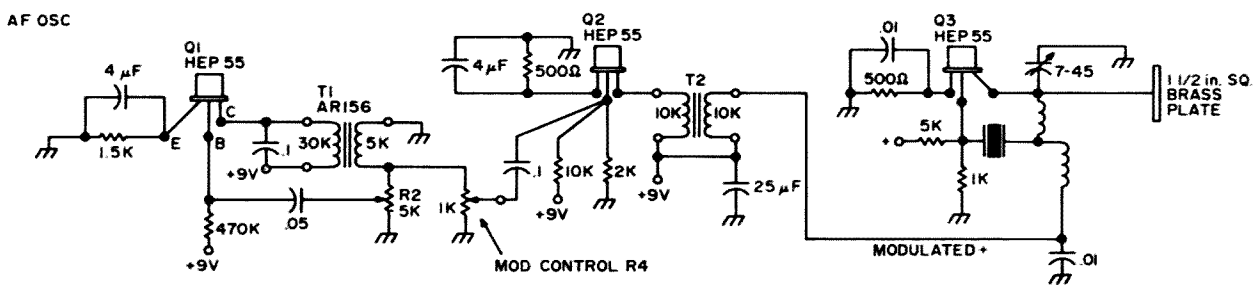
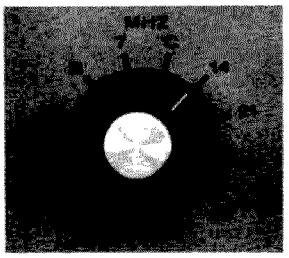


Fig. 2. Schematic of generator. This entire assembly about 3 x 4 in. including small 9V battery and switch must be entirely inside the waveguide. No wire or metal of any kind can be brought outside.

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Circuit

A crystal oscillator, an af oscillator, and a simple class A modulator do an excellent job to start with. Figure 2 shows the present unit as used on 6 meters. It must be stressed again that no wire or other piece of metal may be allowed to reach the outside from this assembly. I'm making up another for 2 meters soon (still my favorite band) and will try one on 450 a little later.

Audio

A controlled-feedback transformer-coupled af oscillator does a good job in furnishing a sine wave. A Motorola HEP55 is used for the oscillator, with feedback to the base from the collector through transformer T1, controlled by resistor R2. Audio output is taken off the 5 kΩ winding of T1, is fed through R4 the modulation control, and then to the base of af modulator Q2. Transistor Q2 is set up for low-power class A operation because not much modulation is needed for the signal generator. Transformer T2 is an old 5W unit from "tube-type portable" days. The secondary of T2 feeds a modulated +9V signal to Q3, the crystal-controlled 50 MHz oscillator.

This rf oscillator is one of my negative-feedback jobs with phase reversal in the crystal. A 1½ in. square plate is tied onto the collector, radiating energy to the receiver pickup plate facing it inside the waveguide. This energy is rapidly attenuated as you move the plates apart, and should be impossible to detect after some 9 or 10 in. of separation.

Once again, do *not* bring any wires or any other metal or conductor out from the oscillator assembly. If you want an outside controlled switch or other control, bring it out as a wooden dowel handle.

That's about it. Tune everything up outside the waveguide on the bench; when you're satisfied, plug your best 6 meter receiver into J1, push the oscillator plank along the waveguide (or rather I should say pull it along) away from J1. You'll get a surprise! Hope this helps you with your low-noise receiver work. It did a lot for me.

. . . K1CLL ■

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Milwaukee WI 53222

Code Practice a la Baby Talk



I was reading the mail on 20 when I let out a groan that brought my wife, Margie, running into the shack. "What's with you?" she demanded. "And don't say it's my cooking."

"Look," I said, waving a hand toward my brand new ham receiver and transmitter built from kits, "Here I got this fine ham gear and I can't talk back to those guys because I haven't a license."

"So what else is new?"

I knew what she meant. It wasn't the first time I'd moaned over my licenselessness. I squared my shoulders, stuck out my chin. "This time I'm really going to learn the code. The theory I know. It's that goshdarn code!"

"That reminds me. You know that ham at the end of the block?"

I groaned again. "Sure I know him. He just got his Extra class ticket. He can copy twenty words a minute and I can barely copy four."

"Well, maybe you could do just as well if you used his method."

My head snapped up. "What method?"

"I met his wife in the supermarket the other day and she said that he learned code by dah-ditting everything he read."

"Dah-ditting?"

"That's right – dah-ditting. At breakfast he'd sound off labels on breakfast food in Morse code. Then on the way to work, he'd do billboards and car licenses in code. She said it was this idea that made it possible for him to pass the code test"

I thought this over for awhile, and then said, "Dah-dah-dah, dah-dit-dah."

"What's that supposed to mean?"

"OK. I'm going to try it."

And I did, the very next morning. As usual, I poked my head into the baby's room. The little tyke looked up, and said "Dah dah."

"Hey," I yelled to the wife, "the kid knows one letter already – dah dah. That's M!"

I heard a dish drop in the kitchen, then my wife's excited voice. "I hope you're not thinking that. . ."

"Well, the thought did occur that Junior and I could talk in code."

"No! Absolutely no! I want my son to talk, not dah-dah throughout life."

I could see her point. I'd be guilty of creating a human oscillator. I apologized and sat down at the breakfast table. Instead of the usual small talk, I vocalized in code the advertising material on cereal packages. I even included the recipes. At one point, I said, "Pass the dit-dah-dah-dah, dit-dah, dah-dah."

Margie's eyes went heavenward. "Oh, what did I start by giving you this dit-dah idea!"

"I only asked you to pass the jam." I chuckled. "It's a great idea. I've got a feeling I'm going to pass the thirteen-word requirement for a General license."

On the way to the office I had a great time translating billboard ads into code. Never before had I been so fascinated by car, beer, milk, and bank outdoor advertising.

When the billboards weren't in view, I'd work on car licenses and speed limit signs. It was while sounding off on a 25 mph speed limit sign that I became aware of a motorcycle cop at my left, obviously wanting me to curb my car.

I stopped, and then as the cop approached I did something out of force of habit. I dah-ditted the officer's badge number in code. He looked at me oddly. "Sorry, officer, I forgot myself. I'm studying the code for a ham license. Those dah-dits were your badge number."

He seemed more than mildly interested. In fact, I believe I detected the very faintest smile. "You were doing 30 in a 25-mile zone." He started to write. "May I see your operator's license?" Then, as if he'd just heard: "Studying for a ham license, eh? Me too."

My spirits soared. "Well, well, well! It's a small world, isn't it?"

He agreed, but went on writing.

"You'll know it's the code that stops most of us," I said. "I just learned about this method of sounding out the code while driving and thought it'd be a great idea. Maybe," I added, "you'd like to try it." I looked at him expectantly.

"No, that'd come under inattentive driving."

I groaned inwardly as he continued to write. "Glad to hear you're going to be a ham," I tried again in a different vein. "What I like about the hams is their great fraternal spirit. . .Nothing they wouldn't do for each other."

The cop nodded and went on writing. Maybe I was being too subtle. "Hey," I said, "I bet if we were hams right now we'd be slapping each other on the back and wishing ourselves good DX."

"Yeah." Just yeah, that's all he said and handed me the ticket. I shoved it in a pocket without a glance.

I was in a bad mood all day and to top it off that evening the wife greeted me with a cheery, dit-dit-dit-dit dit-dit. "That's hi," she said, obviously proud that she'd learned two letters.

"Hi to you too," I said, handing her the ticket and at the same time relating what had happened, adding, "I can't understand it. For one thing, that speed sign wasn't there yesterday, and I was only going five miles above the limit. Furthermore, there aren't any pedestrians there, and. . ."

I stopped. Margie was laughing. I became sarcastic. "How would you like to laugh all the way down to the police station and pay the fine?"

She continued to laugh. "Silly! This isn't a speed ticket. It's a warning. And the officer must like you."

"Like me?" I recalled the ice-water treatment.

"Sure. Look."

I grabbed the official form and for the first time noticed that it wasn't a speed ticket. Scribbled in a strong hand were the words:

"Suggest you use your vocal code practice method when not driving. Hope to work you on 80 CW soon. 73."

I read it once, twice, three times, and then danced around the room, singing, "Dit-dit-dit-dit dit-dit" over and over. Margie looked puzzled. "Oh," I said, "I should explain. . .dit-dit-dit-dit dit-dit is what the CW operator sends when he means "ho ho ho."

. . . W9PXA ■

3 versatile ic testers

Richard Factor WA2IKL
30 West 60th Street
New York NY 10023

As integrated circuits become widely used in industry, large numbers of them find their way into the surplus market, often at prices of a few cents each. The cheaper assortments contain many rejects and are frequently unmarked. With transistor assortments, this is not a problem, since transistors generally have three leads, and only a few trials are necessary to find out if they still "transist."

ICs compound the problem, since they not only have many more leads, but they don't all do the same thing. Figure 1 shows just a few of the many configurations available. With three simple IC testers, you can test and identify virtually all of the ICs a ham is likely to come across (including those of Fig. 1).

After the sweeping claims above, I should clarify some of the things the testers won't do: They will not rapidly and automatically test all the static and dynamic parameters of ICs. They will not automatically check such complex function units as 256-bit read-only memories and other MOS circuits. They will not test the vast assortment of rf and video amplifiers available. They will give no measurements good to 0.1%. But all three can be built for under $20; so if you don't expect the impossible, you can make up a very handy item to have around.

What the testers will do, and do quite nicely, is test RTL, DTL, and TTL digital logic circuits, decade counters, Nixie drivers, and assorted operational amplifiers and comparators, and tell you whether or not they work. And believe me, that's all you really care about.

Testing Philosophy

To test an IC, the simplest thing to do is to regard it as a black box. You apply power to it, connect an input to the proper pin, and observe whether the output is as expected. The procedure for doing this to an unmarked IC is as much an art as a science. I will describe my procedure for going through a batch of ICs. Bear in mind that this is only a representative method –

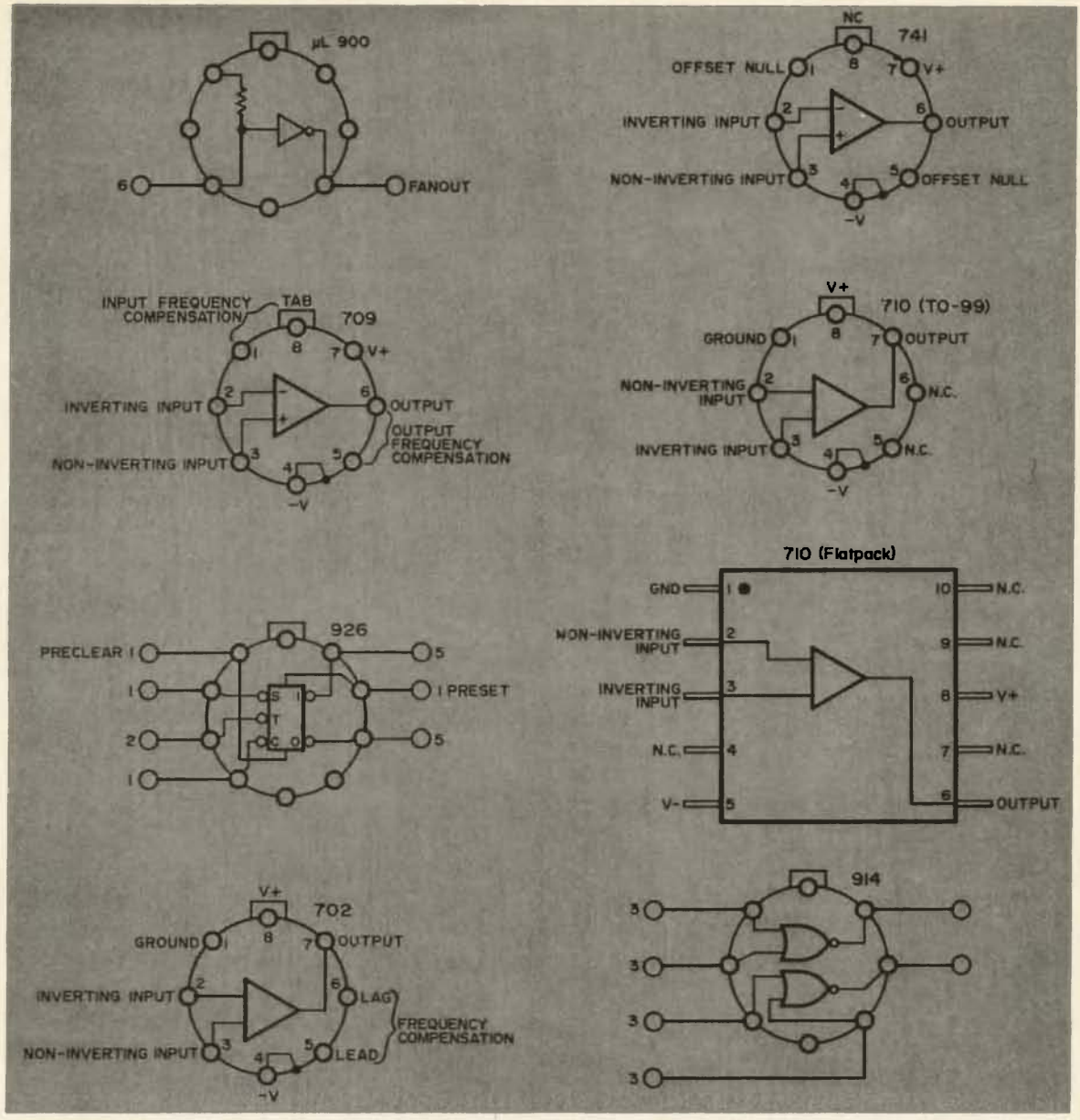


Fig. 1. Connection diagrams for some common ICs. All are shown from top view.

you might hit on one that works better for you.

Assume you have latched onto a handful of unmarked TTLs known to belong to the SN7400N series. This family has gates, flip-flops, and assorted complex functions. Since gates are the most common function, it is best to start by looking for them. Connect the patch cords so that pin 7 is grounded, and pin 14 goes to the +5V terminal. One advantage of looking for the gates first is that these power supply connections cannot damage any flip-flops or counters.

It is a very good idea to have the manufacturer's literature handy so that once you identify an IC, you can label it with a number rather than writing a truth table for it, and so you can avoid pitfalls like improper power supply connections. Insert the ICs into the socket and watch the output current of the supply. When it increases (about 5–10 mA), you have reason to believe that the IC is a gate.

The next step is to look for outputs. The easiest way to do this is to connect the scope successively to each pin while holding the tip of the patch cord. Holding the

cord puts 60 Hz on the scope input. Inputs have very high impedance, and thus the signal will not disappear when the scope is connected to one. Outputs have either saturated transistor outputs in either state (TTL), or low-resistance pullups (DTL or RTL), and will effectively short out the 60 Hz current picked up by the body. Once an output is identified, connect a pulse input to the other pins and find out which ones give an inverted output. This is now sufficient to identify the IC.

Frequently an IC will be perfectly good except for one input. If it has only a minor defect (one of four gates bad, a defective reset on a flip-flop, or such), you can break off the pin corresponding to the defect. This is much more economical than discarding the unit.

Now that we have identified the gates, let's try some other possibilities. Connecting pin 11 to ground and pin 4 to +5V is appropriate for the SN7473N flip-flop. Again, identify the outputs as above and connect the scope to one of them. Connect the pulse generator to the other pins. If you truly have a flip-flop, you should see the pulse waveform divided down to a square wave at half its frequency.

Similar procedures can be followed for almost any digital IC. Some of the newer functions are sufficiently complex to make a data sheet necessary for testing, or you may never hit on an appropriate combination of inputs and outputs. In such a case the digital tester of Fig. 2 can still make valid operational tests, although it will be of little use in identification.

Decade Counters, Nixie Drivers

Counting circuits and readout tube drivers are becoming more popular as their prices decrease. While the SN7490N decade counter can be tested by the above method, it is rather tedious, and the driver cannot be since it is designed to interface with a high-voltage device. To simplify testing of the counter and SN7441N Nixie driver, a special unit was built (Fig. 3) which simulates decade counter operation. Half of an SN7400N (or any other 2-, 3-, or 4-input dual, triple, or quad gate) is used to produce a single pulse each time the SPDT switch is closed. This steps the decade counter, and the Nixie tube is observed for proper operation. Obviously, it is necessary to have a working Nixie driver in the socket when testing the counters, and vice versa.

The 22 kΩ resistor in series with the Nixie is for current limiting. This resistor value depends on the B+ supply and the particular tube used. A rule of thumb is to select a resistor which insures that all of each digit is lit up when the corresponding cathode is grounded. The value is not particularly critical.

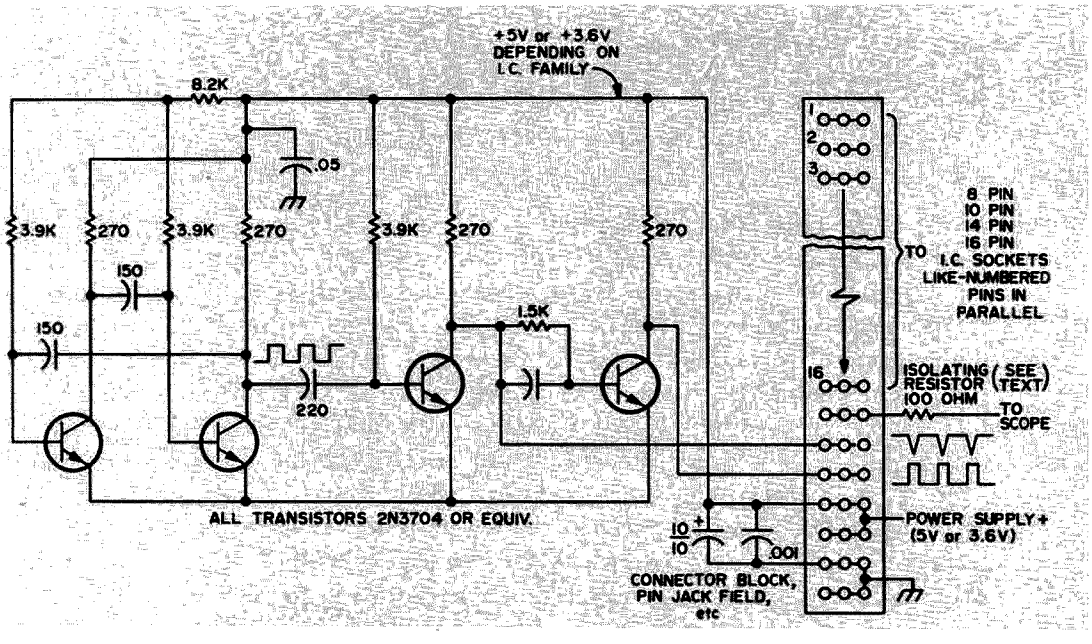


Fig. 2. General purpose digital IC tester.

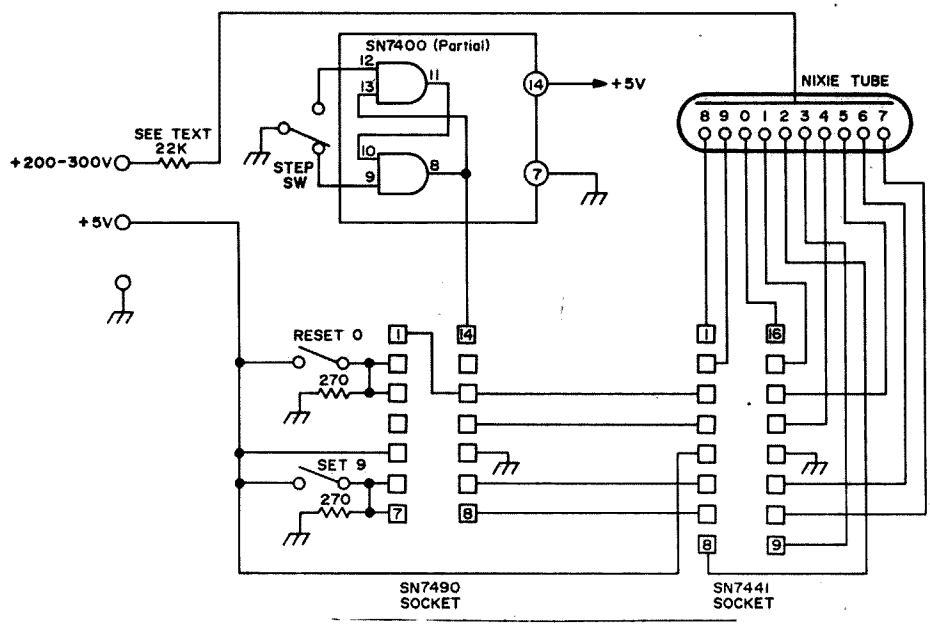


Fig. 3. Decade counter and nixie driver tester.

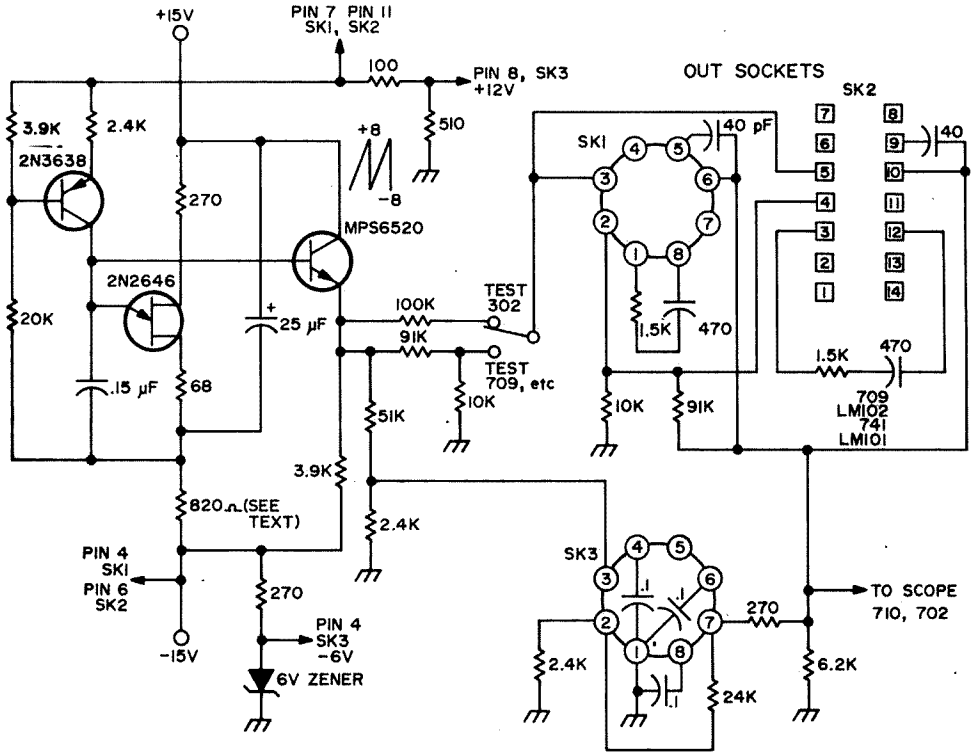


Fig. 4. Linear IC tester.

Linear ICs

Compared to digital ICs, linears are a horse from a different stable. If you have no idea what type you have, you are quite likely to destroy it during the testing procedure. They are designed for a wide variety of positive and negative voltages, and pin connections are quite nonuniform. The most useful type of linear IC is the operational amplifier, or opamp, and the most popular of these is the type 709. They are so popular that the price has plummeted from over $50 to under $2 in

reasonable quantities, and are available from numerous sources. The linear tester (Fig. 4) was designed primarily for 709 and the 710 comparator. It will also test other opamps, such as the LM101, the 702, the μA 741, and the LM102 voltage follower. The diagram showing the test-circuit equivalents (Fig. 5) gives the appropriate output waveforms to look for. The tester doesn't test for parameters such as dc offset and open-loop gain, but does provide a go/no-go test.

The unijunction and current-source transistors generate a linear sawtooth of about 16V amplitude. The approximately 820Ω resistor is adjusted so that the voltage swing is symmetrical about ground when measured at the emitter of the MPS 6520 buffer. This signal is then appropriately attenuated and applied to the device input. The 709 output should be a symmetrical linear sawtooth of 16V amplitude. The 302 output should be similar, but without attenuation. Testing the 709 without attenuation will show its peak-to-peak output swing, without delivering enough current to damage the input. A tester switch is used to control the attenuation.

Building the Testers

The diagrams are more or less self-explanatory. The only special component used in any of the testers is the patching arrangement for the digital IC tester. I used some sort of connector block into which small conical pins fit. It had been lying around for so long that I forgot where I got it. If you can't find something like this, you might try an arrangement of terminal strips and alligator clips, or perhaps a field of pin jacks. Also, while it is not shown on the diagrams, it is a good idea to bypass the power supply connections to ground as near to the IC sockets as possible, especially in the linear IC tester.

Unless you're an old pro with ICs, testing them is not as boring a job as it may seem. It is impossible to describe a complete test procedure for all digital ICs, since they fail in as many ways as there are internal components. It is highly instructive to test the ICs with both the pin diagrams and the internal schematics in

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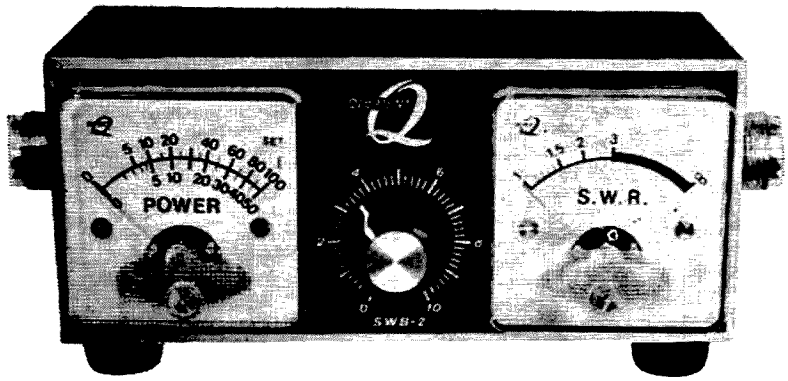
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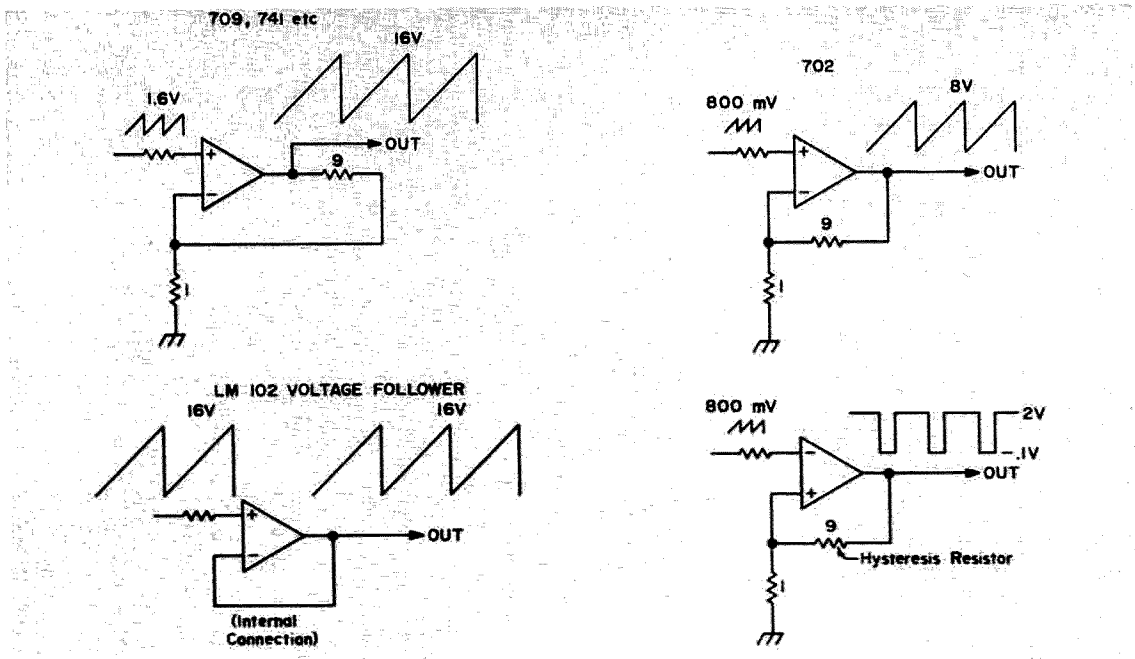


Fig. 5. Simplified test circuit equivalents.

front of you. It will give you insight into IC operation and a better knowledge of logic functions than can be obtained from the literature. And the money you save from salvaging just a few ICs can equal the cost of the testers.

. . .WA2IKL ■

OPTIMIZING ANTENNA SEPARATION IN FM REPEATERS

by Ken W. Sessions, Jr. K6MVH

If the receiving range of your repeater can't match the output capability, the problem could be desensitization. And chances are you can solve the problem by as simple a step as moving the antennas around a bit at the site.

It was a long trip and it had seemed like an eternity since I left the last metropolitan area and all the concomitant repeater activity. I was looking forward to driving through the next big city, which I knew to be a highly populated repeater stronghold. I kept watching the roadsigns so that I could get some idea as to the coverage in miles I could expect from that famous repeater. And every so often I would key my .34 transmitter and listen for a telltale squelch indication on .94.

Just when I thought I was going to fall asleep from fatigue, I got the squelch tail I had been looking for – 68 miles out of the city! With new vigor, I hit the button and put out a call. No answer. It was only 10:30 at night, so I was pretty sure there must be at least one lonely soul more interested in chatting than in watching the evening lineup on TV. After a few more miles, I called again. No answer.

Strange. Who would think that such a renowned repeater would be so forsaken this early on a Friday night? I passed the 50-mile marker and tried again. The squelch tail was not full quieting; the delay was long enough so that I could be absolutely sure that I was making it in, however. There was still no answer.

Not one to give up easily, I tried again and again – past the 54- then the 42-mile markers. Eventually chagrined, I reached over to change my transmitter to .94 – and the first signs of life began to appear on the repeater.

From the repeater came, "Why don't you knock it off, fella. . .you're not disturbing anybody."

I gave my call again and tried to make contact with the voice.

"So keep it up," it said. "All you're doing is wearing out your finals."

Was the guy drunk? Was he talking to me?

"Hello, there," I said into the microphone. "Are you copying me?"

Then another voice came on. "Hello, Jack. . .what's up?" (Squelch tail.)

"Same old thing, Ray," the first voice said. "The lid is back playing with the repeater again." (Squelch tail.)

"Break," I said. And there was no squelch tail because Ray was talking.

". . .ignore him long enough and he'll just go away." (Squelch tail.)

"Break," I said. And a squelch tail followed.

"Go ahead the break." (Squelch tail.)

I had just passed the 35-mile marker.

"What's going on, fellows?" I said. "I've been hitting your repeater for the last 35 miles but all I've been getting is the brushoff. I thought something had gone wrong with my audio. This is K6MVH mobile – does my audio sound okay?"

"Better try again, old man. You're not quite making it into the repeater. We'll stand by for you." (Squelch tail.)

"Not making it in? Are you kidding? I've got a 15-watt rig here and I've been keying the repeater for more than a half-hour. How could I not be making it in?" I dropped carrier and heard the distinctive kerchunk.

"Did you get any of that, Jack?" Ray said.

"Yeah. . .I think it was a mobile. Hang on till you get in a little closer, old man, you're still too far out for good copy."

I was incredulous, but obedient. I drove on, listening to the two carry on their conversation. At the 21-mile mark, the road inclined for a few hundred yards, so I pulled to the side at the top and gave another call. This time they heard me, but I wasn't much out of the noise.

There was nothing wrong with my audio, I learned. And there were no problems with my transmitter or mobile antenna system. The repeater was merely experiencing a "little" desensitization. The repeater owners had put up the machine but had not yet found the cure for their desensitization problems; nonetheless, they wanted as much range on the repeater as they could get, so they set the receiver squelch to its threshold point.

The result was that the repeater users were being driven right up the walls from signals they had been attributing to "lids" and "troublemakers." They could hear the repeater being keyed frequently, but since they couldn't hear anything but garbage, they assumed each unintelligible input was a local clown.

If the anecdote sounds all too familiar, don't blush. Desensitization is far more common than you might think. It's just that when you hear about the wonders of someone else's repeater, the fellow who tells you about it generally has a way of overlooking some of the less attractive aspects of it. The truth is, the repeater I described could be any one of a dozen in the West, several in the Midwest, and a few in New England. The "mile markers" might have been different, but the situation – the lack of parity between input and output and the horrendous degree of desensitization – is strikingly uniform from one repeater to another.

There have not appeared too many articles on defeating desensitization – virtually nothing in the major journals. The measures that have been taken in most instances have been the result of dogged determination and untiring experimentation on the part of the amateurs who build the repeaters. Moreover, in the majority of installations, the problems don't seem serious enough to warrant the often rather dramatic and time-consuming effort described by the scant literature on the subject.

To minimize receiver desensitization in a typical repeater, some means must be employed to attenuate the transmitter signal at the receiving antenna location. The degree of attenuation required for any given repeater application can be predicted, however, with a fairly high reliability if certain key parameters are considered as "constants." And, since

REPEATER OPERATING FREQ	HORIZONTAL SEPARATION 510	512.5	515	517.5	520	522.5	525	527.5	530	532.5	535	537.5
510			1K*	660	435	342	280	199	161	130	110	100
512.5				1K+	610	430	340	259	198	161	130	110
515	115				1K	660	425	336	258	197	160	130
517.5	90	112				1K	660	420	336	257	196	160
520	70	90	108				1K	640	418	334	256	195
522.5	62	70	89	105				998	630	410	332	255
525	55	61	69	88	103				995	620	405	330
527.5	47	54	60	68	87	100				990	610	400
530	42	46	53	59	68	86	99				985	600
532.5	36	40	45	52	58	68	85	98				980
535	32	34	38	44	50	57	67	84	97			
537.5	28	30	32	36	43	48	56	67	83	95		

VERTICAL SEPARATION, ft

VERTICAL SEPARATION

HORIZONTAL SEPARATION, ft

Fig. 1. Tabular listing of required antenna separation in feet for various 6 meter repeater frequency combinations. The gray area shows separation requirements for horizontally spaced antennas; the white triangle shows distances for vertically separated antennas (tip-to-tip).

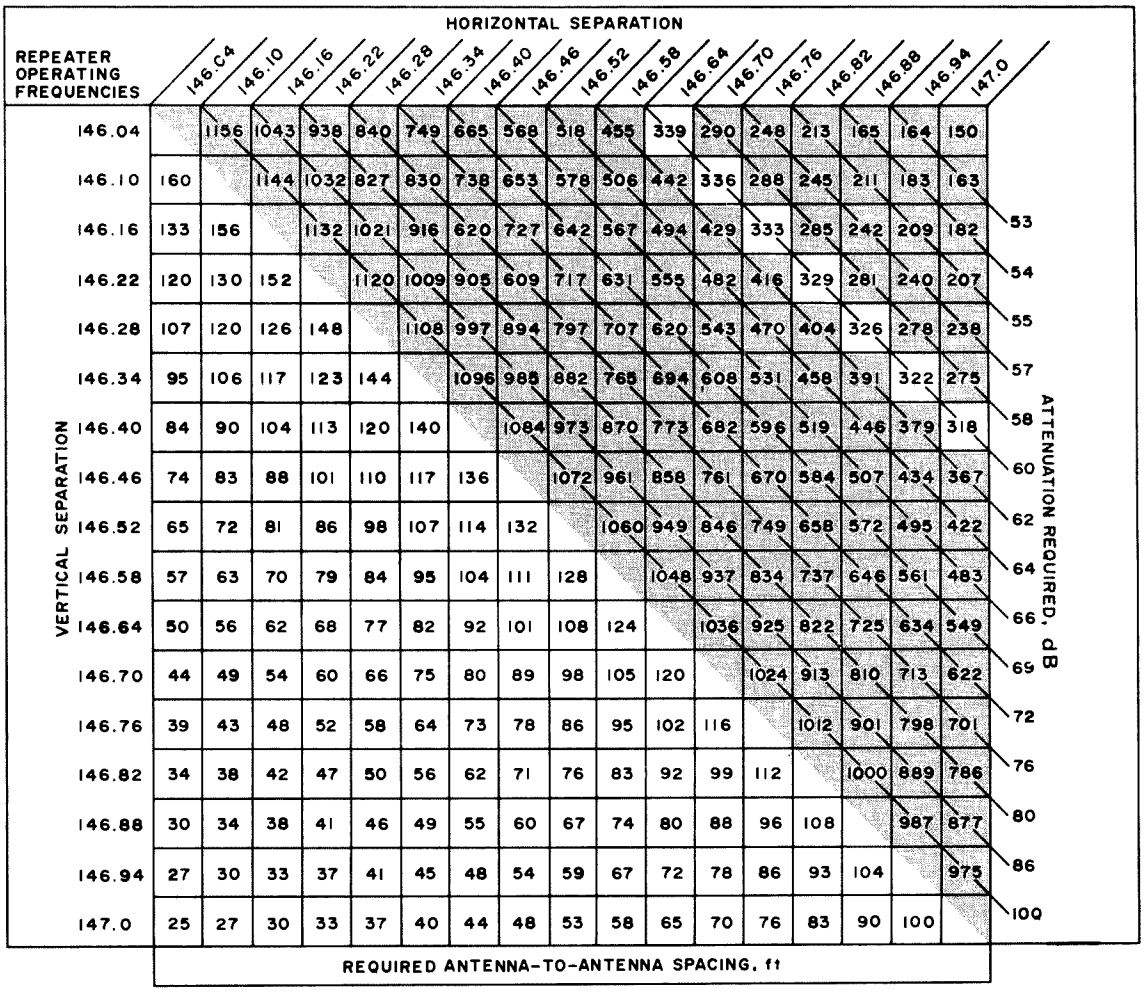


Fig. 2. Minimum tip-to-tip spacing (in feet) required between transmit and receive antennas to achieve various attenuation values. Shaded area is for horizontal separation; white area is for vertical. Diagonal lines represent attenuation level attained by tabulated separation in typical case.

most amateur repeaters are similar in many respects, the constants aren't difficult to nail down. As rules of thumb, then, these can be considered to be: a transmitter output power of 50W or less; a receiver sensitivity of 0.5 μV (for 20 dB quieting) under normal, nontransmit conditions; use of conventional omnidirectional antennas, receiver selectivity typical of modern commercial two-way FM units, use of a well-matched antenna for both transmit and receive; and installation of high-quality, low-loss coaxial cable.

The cheapest and easiest method of minimizing desensitization is through careful separation of the repeater antennas. Assuming all the constants cited above apply to your own VHF repeater setup, you can readily determine how far apart your transmit and receive antennas must be placed by consulting the charts of Figs. 1 (6 meters) or 2 (2 meters).

Understanding Attenuation Requirements

It is easy to see from examination of the tabulated figures that the closer the repeater operating frequencies are to one another, the greater the attenuation required. With 500 or 600 kHz of spectrum between the two frequencies – as with most of the 2 meter repeaters – some means must be employed to attenuate the transmit signal by about 60 dB (shown by diagonal line on Fig. 2). If no other method is used to obtain this isolation, it can be effected by placing the two antennas some 50–60 wavelengths

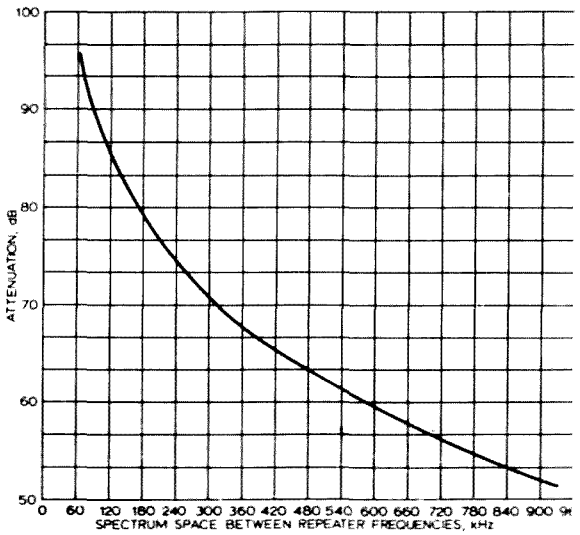
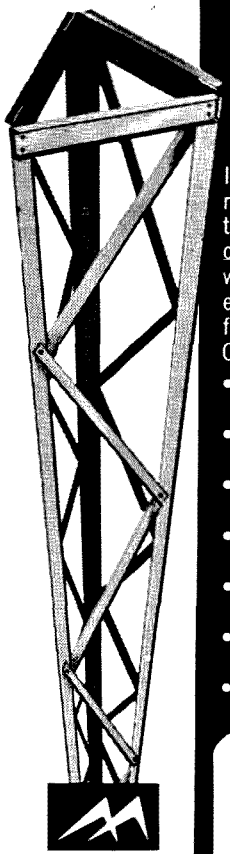


Fig. 3. Attenuation curve shows how isolation problems can be simplified by providing more spectrum between the repeater operating frequencies. As shown, the attenuation requirement gets extremely severe whith close-spaced channels.

apart horizontally or by spacing them about 8 wavelengths vertically.

Since the spacing is directly proportional to wavelength, the higher frequencies require less distance between antennas to achieve a given isolation value. It is easier, for example, to isolate 146.94 from a 147.00 MHz transmitter than it is to isolate 146.70 from 146.76 MHz, even though the spectrum between the two sets is the same (60 kHz). From Fig. 2, 100 ft of vertical separation is needed between the antennas on the top end of the spectrum, and 116 ft is required to give the same degree of attenuation for the lower set.

The curve of Fig. 3 shows the attenuation required as a function of spectrum spacing between the two repeater operating frequencies. When you consider that each 6 dB of attenuation represents halving the field strength (in measurable voltage) at the receiving antenna, it is not too difficult to see why repeater owners keep the transmit and receive frequencies as far apart as possible. Consider the attenuation requirement for a 60-kHz-separated repeater, for example, as compared with a repeater system with operating frequencies spread by 600 kHz. As the frequencies are brought together, the



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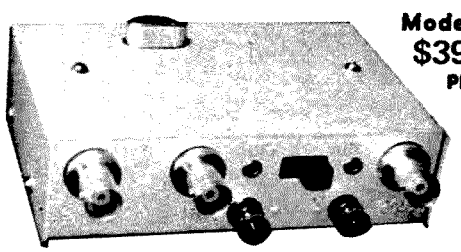
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attenuation requirements get downright formidable.

If your tower will not permit the minimum separation distance as determined by the charts, you will have to plan on either more spectrum between the transmit and receive frequencies or incorporation of additonal isolation measures, such as cavities or hybrid rings. The only other alternatives are placing the receiver site physically at some distance from the transmitter or separating the two antennas horizontally by mounting them on two different towers.

It should be understood that an isolation factor of 60 dB (which the 600-kHz-spread figures are based on) is a minimum, and it results in a desensitization level of about 2 dB – a value considered acceptable by most amateur and professional repeater men.

Horizontal separation is usually a last resort because it may take as much as ten

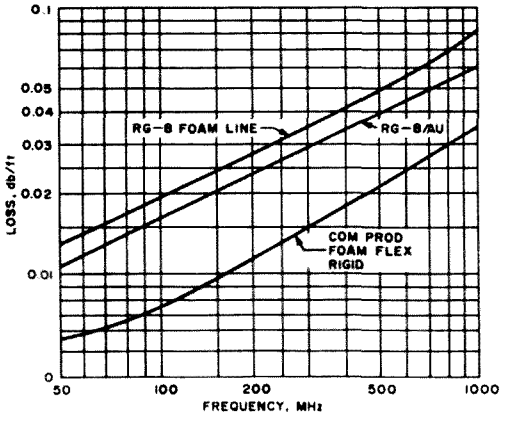


Fig. 4. This chart shows the superiority of foam line over conventional RG-8A/U cable. For a 100 ft run there is 0.5 dB less loss with their "equivalent" foam line at 150 MHz, and only 1 dB of total loss with ComProd's rigid foam line.

times the distance horizontally that it takes vertically to achieve a given attenuation level. In the 60 dB attenuation example above, for instance, a vertical separation of only 45 ft does the job. If the antennas are to be separated horizontally, however, the physical spread between the two antennas must be increased by no less than 322 ft. This characteristic is attributable to the fact that antennas typically radiate most of their energy in an almost perfect horizontal plane. Not only does the transmit antenna pump out more radiation horizontally, but the receiving antenna is pulling in signals better along that plane. With vertical separation, though, both antennas are placed in a position least susceptible to direct radiation of the other.

Another major disadvantage of horizontal separation with a single-site repeater is the excessively long runs of transmission line usually required. No matter what type of coaxial cable is used, a 400 ft run means plenty of signal loss – particularly at the higher frequencies. Figure 4 shows just how much loss you can expect with RG-8A/U and foamline equivalents at the various VHF and UHF frequencies of interest to amateurs. At moderate power levels, extremely long runs of conventional coax would seem almost prohibitive, even at 150 MHz. A figure of 0.025 dB/ft for signal attenuation may not seem like much, but it results in a 10 dB loss with a 400-ft length of transmission line – which is a power loss of a full order of magnitude, turning fifty watts into a measly five.

Use of a very high grade of line, such as Communication Products' rigid Foam-Flex, will cut the loss to about 1 dB per hundred feet; a better alternative, of course, but still a significant loss. And consider the cost of a 400 ft length of this "good stuff." It isn't cheap!

Clearly, horizontal separation of antennas is not a sound solution from a single site under ordinary conditions, particularly on the lower VHF frequencies.

All this discussion is not meant to be a course in repeater planning; the object is merely to help you determine the best possible way of providing good solid repeater coverage using only the facilities that you have available.

Tricks You Can Do

If you looked at the vertical separation charts of Figs. 1 and 2 and decided that there was not enough room on your

tower to accommodate both your repeater antennas, don't resort too soon to going the horizontal route. There are still a few more aces you can play.

Many service specialists – both commercial and amateur – are surprised to learn that when "gain" antennas are spaced vertically, one or the other of the two may be moved a few inches *horizontally* to yield an *effective* increase in separation distance and a positive improvement in signal isolation by as much as 3 dB. This interesting phenomenon can be explained on the basis of the radiation-pattern peculiarities of individual antennas (though virtually all of the collinear omnidirectional antennas are similar). From the typical pattern of Fig. 5, you will notice that a collinear omnidirectional gain antenna produces lobular "spikes" below the radiator and along the same axis. Most antenna manufacturers publish typical patterns (as in Fig. 5a) that show a symmetrical placement of these minor lobes. In practice, however, these lobes are not necessarily symmetrical, even though they are always present. Their appearance will depend on such factors as antenna placement, distance from tower, size of mast, etc., and they will rarely form the symmetrical arrangement sketched in Fig. 5a. The measured pattern will form a hodgepodge of lobe spikes as pictured in Fig. 5b.

If the lower antenna is positioned at the null between these spikes, maximum attenuation will result. If the lower antenna is centered on one of the lobes, however, adequate isolation may be very difficult to achieve. A few inches to a foot laterally may make all the difference in the world!

One excellent way to determine the best position for the second antenna is to take actual field-strength measurements at various candidate locations on the tower while the transmitter is pumping a signal into the first (mounted permanently). For vertical-separation checks, load the transmitter into the upper antenna (even though it may eventually become the receiving antenna), then do a thorough job of checking the field strength of the signal at various positions lower on the tower. When an optimum location is found, mount the antenna there loosely, then connect it directly to the field strength measuring device. While monitoring for a null, move the antenna as much as possible within its confines. Then secure it when the reading is optimum.

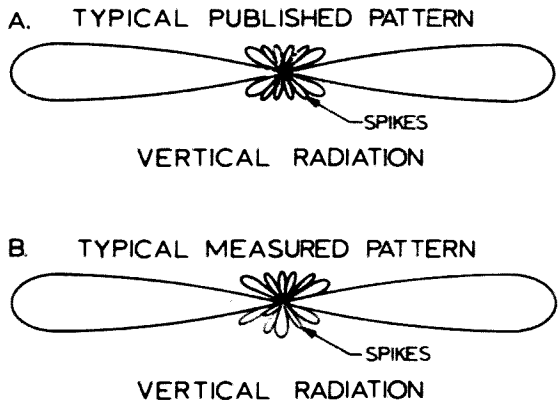


Fig. 5. The measured radiation characteristics of an antenna will often differ from that specified, particularly with the minor lobes directly above and below the radiator. Published patterns show symmetrical minor lobes with a null directly above and below the antenna. Actual measurement may show nulls slightly off-axis from the radiator. Experimentation with one of the repeater antennas will quickly show where the null points are.

Another trick in common use is the inversion of one of the two vertically separated antennas. With gain antennas, this procedure may not offer some of the fallout advantages to be realized with groundplanes because most gain antennas have a characteristic radiation in an almost perfect horizontal plane. So there is rarely an actual signal improvement when a gain antenna is inverted, but the reduction in desensitization can certainly make it worthwhile. If the vertical lobes of the upper gain antenna (that is, the spikes extending directly below the upper antenna) are difficult to avoid with the lower, turning the *top one* upside-down and jockeying for position will almost certainly cure the problem, *provided the tip-to-tip spacing between the two antennas can be preserved.* If the tip-to-tip spacing must be compromised by invert-

ing the higher of the two antennas, it might be wisest to try inverting the lower one. This tends to increase tip-to-tip spacing, but could cause problems of interference with other structures if the lower antenna is mounted in the vicinity of a rooftop, the ground, etc. Individual installations will have to be made on the basis of these considerations.

An important note: When a gain antenna is inverted, great care must be taken to insure that *absolutely no moisture* gets into the fiber-glass casing. A little water and you can kiss your expensive antenna goodbye.

Groundplanes make particularly good antennas for inversion because they characteristically have a very high angle of radiation (generally about 23 degrees above the horizon). Inverting the *lower* one will provide the highest degree of signal isolation, and will probably get you a little extra gain on the low horizon because of the change in primary radiation angle. Inverting the upper one may or may not help your desensitization, but it will certainly improve your radiation angle. Your best bet is to try it both ways – first the lower antenna, then the upper one. At least with groundplanes, there is no need to fear compromising the tip-to-tip spacing between antennas.

The Last Step

There is still one other repeater improvement technique that can be employed, but it is the one least used by repeater people. It takes practically no effort, and results in a system that is greatly improved in terms of actual usefulness. The trick? Nothing more complicated than a simple adjustment of the repeater squelch. But for some reason – no doubt intrinsically involved with ego in some way – repeater owners are all too frequently quite reluctant to do it.

The rule is this: Don't set a loose (sensitive) repeater squelch unless the transmitter can reproduce a weak input signal without degrading the performance of the receiver. The problems I incurred during my trip could have been avoided completely if the local repeater talent had adjusted the repeater squelch to a realistic level. When my signal was too weak into the system to overcome the desensitization problem, it should have been kept from being repeated and providing an annoyance to the local stations who monitor the frequency. Repeater owners should bear in mind that even if a repeater can be activated by a weak station, this is not necessarily a guarantee that the output signal will be copyable by the users. And there is nothing so disconcerting as a repeater being constantly keyed by unintelligible signals.

Many convention-goers found this out at the recent Orlando hamfest when a hastily installed repeater was set to retransmit threshhold signals. A number of walkie-talkies were turned off because of the annoying and unintelligible garbage that was being relayed the first night. A flick of the wrist at the receiver on the second morning of the FM convention, however, cured the problem, and the repeater was once more the useful and enjoyable communicationns medium that it was designed to be.

In short, if the range of the receiver doesn't match that of the transmitter, look for excessive desensitization. If you seem to have that problem whipped and the range imbalance still exists, try lowering the transmitter power. This will achieve the dual purpose of dropping whatever desensitization that may still exist and effectively bringing the range of the transmitter in to more closely approximate that of the receiver. Finally, set the squelch on the receiver so that those signals too weak to be copied do not even get repeated.

The result? Your repeater will be as busy as ever, but with cleaner signals – and you'll find more people monitoring more often during the inactive periods. But most important, your repeater may get the reputation for having input and output coverage that is ideally balanced. What better compliment to your system than to have people say, as they do of the Buffalo repeater, "If you can hear it, you can use it!"?

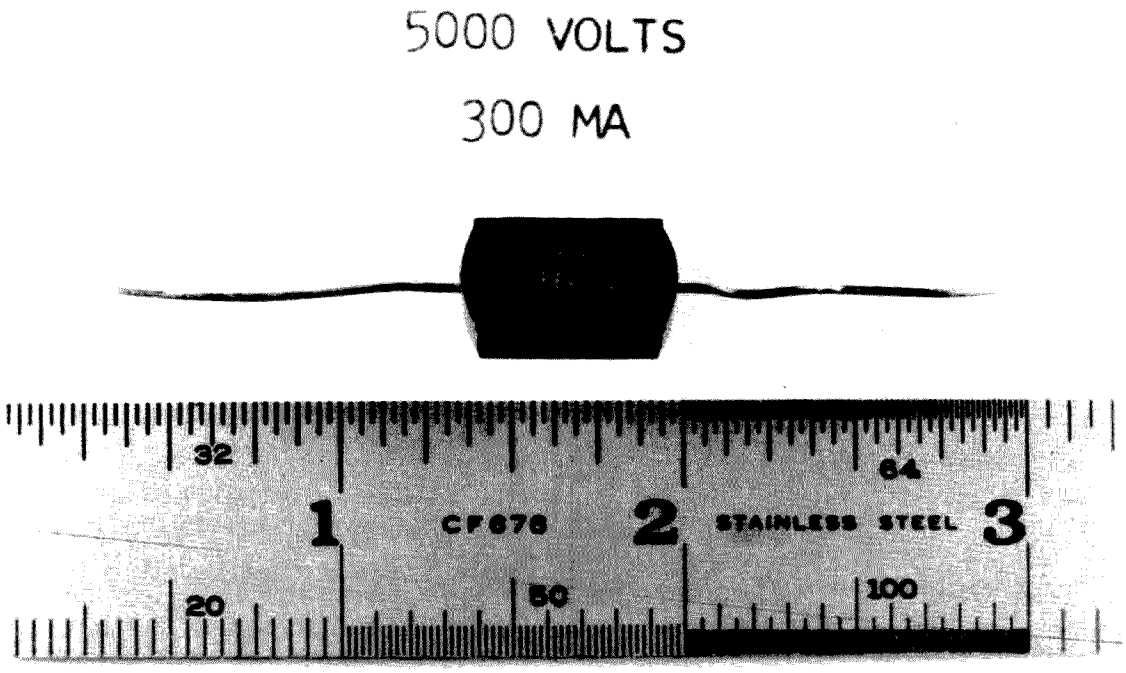
. . . K6MVH ■

Robert F. Schuetz W2BDG
General Electric Company
Buffalo, NY

More Notes on Diode Stacks

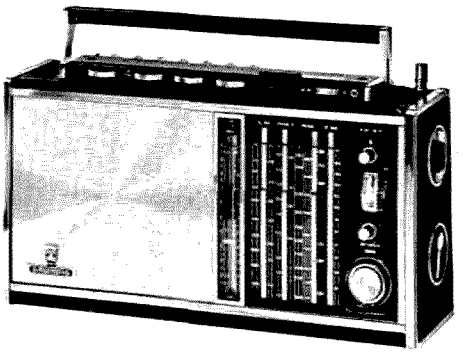
While reading K6KA's excellent article on diode stack power supplies (73 Magazine, September 1969), I thought of a recent experience I had where I replaced two 3B28's with silicon rectifier stacks. The particular power supply used was a 3 kV centertapped transformer, 8 μF oil-filled capacitors, and a 50Ω current-limiting resistor. A relay in the primary of the transformer is connected to the push-to-talk relay in the transceiver and push-to-talk operation is normally used.

I obtained some GE rectifier modules (Part A1423) rated for 5 kV at 300 mA and substituted them for the tubes. The only special precaution I took was to keep the leads short. No special transient suppression circuits were used and the power



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Bandspread	28.3–29.8	Longwave
Tuning	26.9–28.3	150–450 kHz
(includes CB)	20.9–21.7	
	13.8–14.5	
(includes CHU)	7.0–7.35	Broadcast Band
(SW Broadcast)	5.95–6.25	510–1650 kHz
	3.5–3.8	
	1.7–2.0	HiFi FM (Wideband)
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supply has been operating satisfactorily for about six months. The photo of the rectifier module shows its small size.

Higher voltage stacks are available from GE in the same package; however, I recommend using two of the 5 kV stacks in series to obtain higher voltage ratings, as necessary. Use of a voltage rating considerably above the peak voltage to be expected will insure a long trouble-free life.

The units are relatively inexpensive (about $4 each) and are advertised to be avalanche-protected. As with any semiconductor rectifier, the factor limiting the current rating is the heating of the junction, which is caused by the forward current and the voltage drop across it.

In order to safely exceed the current rating of a rectifier or module, the heat must be removed. The easiest way to do this is using short leads to a heatsink; other ways are by heatsinking the body of the unit, by blowing cold air past the unit, or by adding radiating fins.

Most rectifiers are rated at a temperature above room ambient and this adds a little leeway in the current rating. For example, the 300 mA rating of the 5 kV module referred to earlier is at 50° C and ½ in. lead length, at 25° C the rating is over 350 mA. With single sideband equipment, rectifiers get a chance to cool between voice peaks and most power supplies are full-wave, which reduces rectifier heating somewhat.

The usual cause of failure in low-current silicon rectifiers is loss of blocking capability rather than forward current overload. Loss of blocking capability is often caused by voltage transients exceeding the rating of the rectifier – hence, the recommendation for a large voltage safety factor.

Avalanche- or transient-protected rectifiers will usually handle a small amount of power in the reverse direction, where small voltage pulses may be higher than the rating; however, it is much safer not to operate close to the voltage rating.

I have had good luck with these rectifier modules even though I'm probably not using them as the manufacturer intended.

. . .W2BDG

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India

DELUXE RECEIVER GAIN CONTROL

It is well-known that for obtaining optimum gain and noise figure, the front-end of a tube-type high-frequency communications receiver should emloy a high-transconductance sharp-cutoff pentode run at maximum gain without agc. However, most commercial receivers use a variable-μ pentode for the convenience of easy gain control.

When I pulled out the 6SG7 amplifier in my receiver and directly substituted a 6SH7 sharp-cutoff pentode, the improvement in the sensitivity and noise figure of the receiver was truly remarkable. The plate voltage was 250V and the screen voltage 100V. A cathode bias resistor of 100Ω was provided and agc was disconnected from the first stage.

This improvement in performance, however, is accompanied by a drawback. With strong signals, there is overloading of the mixer, resulting in distortion and audio splashing. This can be eliminated by inserting a separate gain control in the form of a potentiometer in the cathode line of the rf amplifier. Although the range over which the gain of a sharp-cutoff pentode can be varied without curtailing its signal-handling ability is limited. sufficient variation in gain does occur to prevent overloading of the mixer with strong signals.

When using a sharp-cutoff pentode in the front end, the ideal way of controlling the receiver gain is therefore to run the rf amplifier at full gain on all but very strong signals, and reduce the gain just to the extent necessary on strong signals. Figure 1 shows a circuit in which the rf gain of the

front end is electronically locked to the i-f gain and tracks with it in the desired manner. The circuit needs just one transistor, a zener, three resistors, and a bypass capacitor. The values of the three resistors shown in the figure should be taken only as a rough guide; for every receiver, the proper values of the resistors are to be determined experimentally, as explained below.

To start with, a 10 kΩ potentiometer is temporarily used as a separate rf gain control. A very strong signal is tuned in and the gain control is backed up until all traces of front-end overloading disappear. The resistance of the potentiometer then gives R1. The corresponding cathode bias will be of the order of 4–6V.

R2 determines the cathode bias at full gain. Its value depends on the tube and transistor characteristics and should be determined experimentally so that the cathode bias at full gain is the recommended value for the tube (−1.0V for 6AU6 and 6SH7; −2.0 volts for 6AH6 and 6AC7).

V1: 6AH6, 6AU6, 6AC7 OR 6SH7.
V2, V3: 6BA6, 6BG7 OR 6SK7.

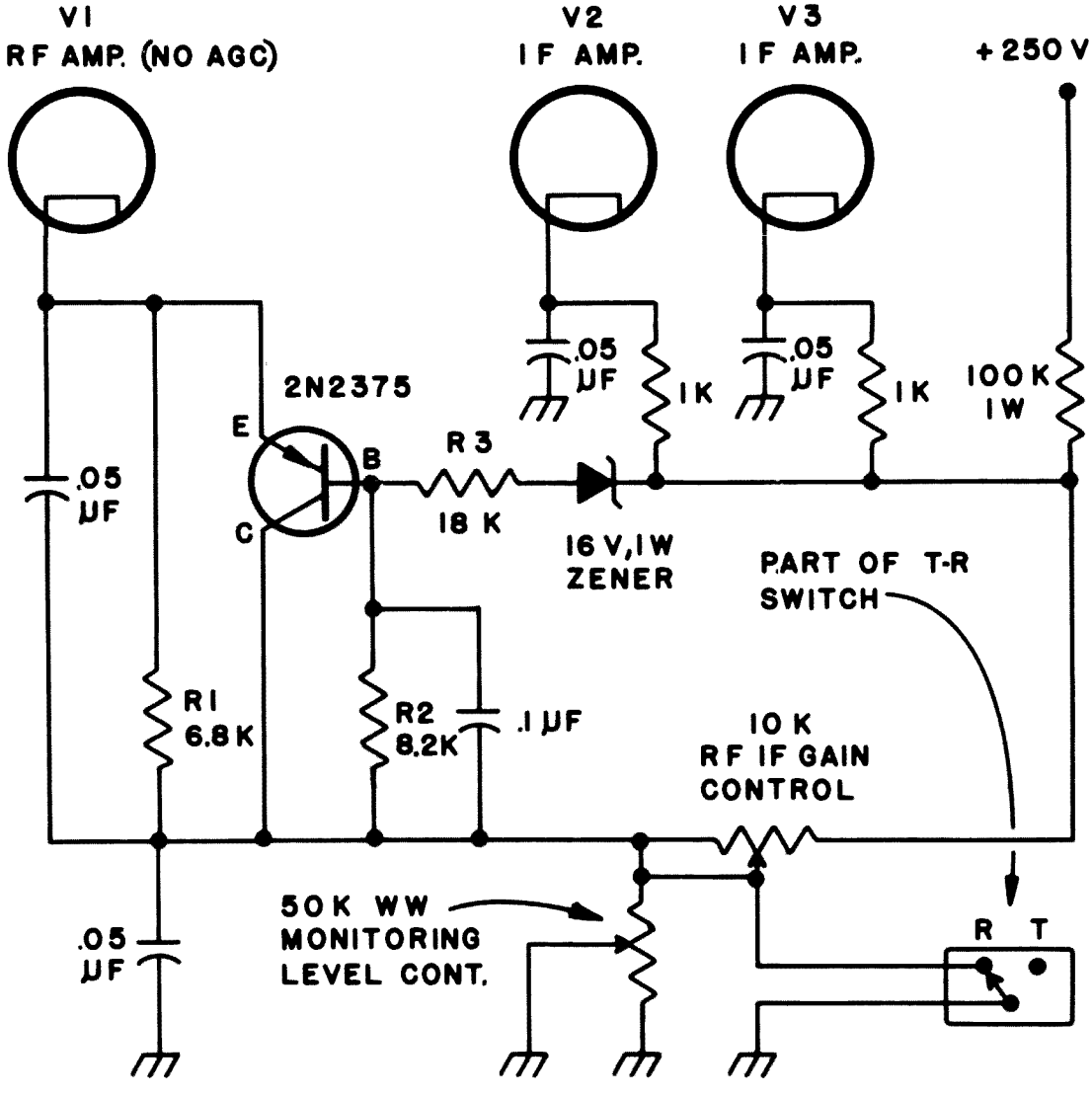


Fig. 1. In this circuit the front-end gain is "locked" onto the i-f gain and tracks with it.

The zener determines the bias voltage at which the rf gain begins to track with the i-f gain. Zeners in the voltage range of 16–22V will be in order. I did not encounter any noise or avalanche problem in using the zener. As the bias voltage of the i-f stages rises, the zener current increases the base voltage of the transistor and lowers its conduction, thus raising the cathode bias of the rf amplifier.

R3 governs the tracking of the rf gain with the i-f gain. Its value should be such that with the gain control at minimum, the cathode bias of the rf amplifier just approaches the maximum usable bias determined at the outset.

The transistor used should be a low-leakage high-gain PNP germanium transistor. The 2N2375 which I used showed an I_{ceo} of less than 100 μA and a beta of 100 under normal test conditions. Since the transistor has practically negligible collector dissipation, it is able to survive in the very unfavorable surroundings inside the receiver chassis!

In the transmit position, the 50 kΩ monitoring level control comes in series with the rf gain control. This overbiases the i-f stages while the rf amplifier, in view of its sharp-cutoff characteristic, gets completely cut off. This permits comfortable monitoring of the transmitted signal.

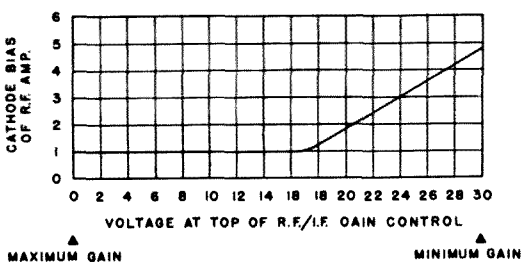


Fig. 2. Tracking curve shows smooth voltage transition with increased voltage bias.

Figure 2 shows the observed smooth tracking of the rf stage bias with the i-f stage bias. Flattening of the right end of the curve due to the transistor getting cut off can be avoided by increasing the value of R3. The performance of this gain control leaves little to be desired.

. . . VU2JN ■

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A New Approach to Communications Equipment

New amateurs are aware of the cost to develop new pieces of amateur equipment. This cost can sometimes run into millions of dollars. Most amateurs are aware of the high cost of quality equipment with all the features they might want. The three traditional methods of beating this high cost: buying used equipment, building your own, or modifying surplus; each leaves something to be desired. Additionally, improvements in circuits and various other changes tend to leave the amateur with the choice of extensively modifying complex equipment or buying new gear. This need not be. There is an approach to designing communications equipment that can significantly reduce these problems, while providing almost infinite flexibility.

In my field of high energy physics, experiments are controlled and results recorded by racks and racks of electronic modules. Since each experiment is quite different from any other in logic and control, this equipment is assembled from small plug-in modules of simple logic functions which can be connected in an infinite variety of ways. This same approach should be used in communications equipment.

Figure 1 is a block diagram of a typical SSB transceiver. Note how it can be broken down into a simple group of functions. By placing different functions in different plug-in modules, a very flexible piece of

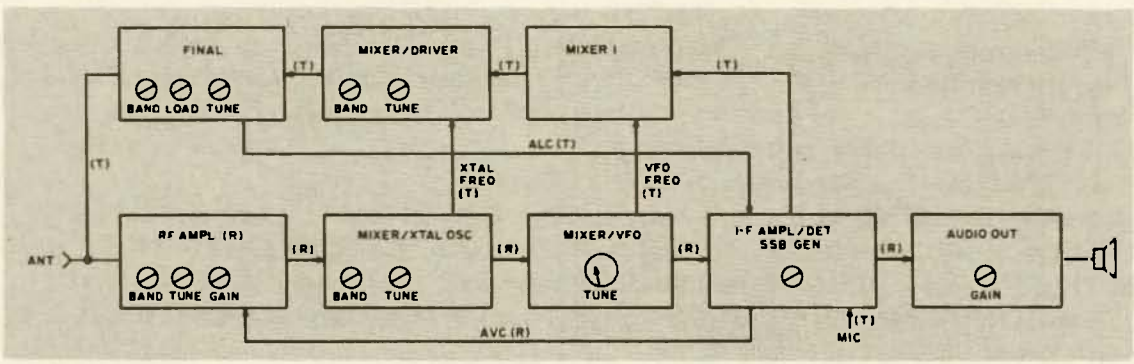


Fig. 1. Block diagram of a typical SSB transceiver.

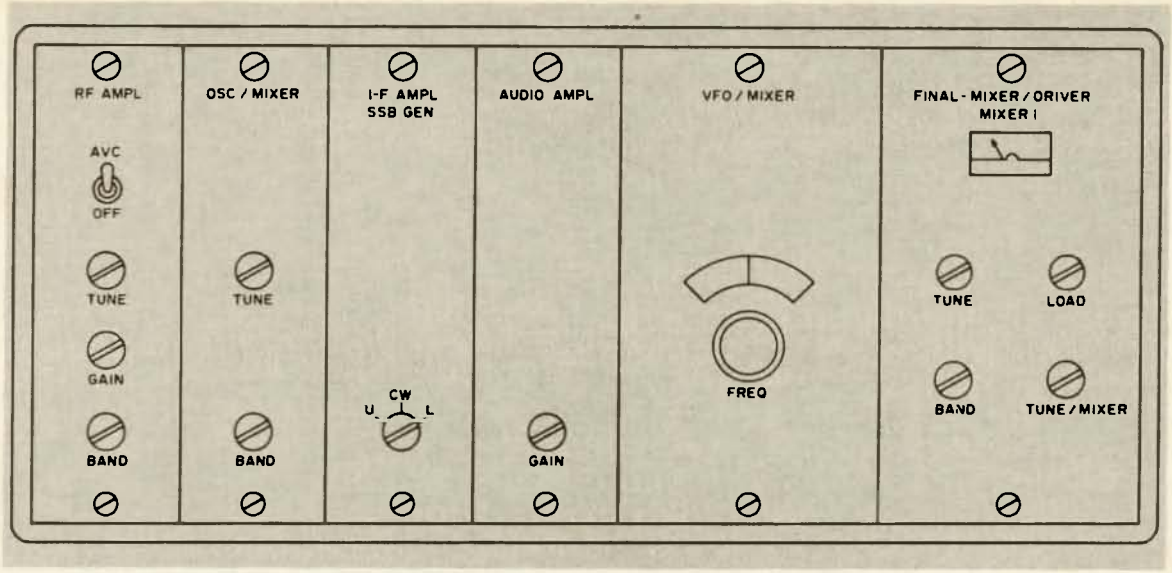


Fig. 2. Front view of a typical SSB transceiver.

equipment emerges. Figure 2 is a front view of such a transceiver. Several functions are combined in some of the modules to fit into one chassis. If separate chassis are used for transmit and receive, some of the modules would need to appear in only one and serve both chassis if desired. If the chassis design, connector, and signal specifications are standardized among various manufacturers, then any module purchased from any manufacturer or one made at home can be used interchangeably. The user can purchase only those functions he wishes to use and not be required to pay for undesired capabilities. He may choose to purchase each module from a different manufacturer or build his own, depending on which is most appropriate for him. Men who like to experiment may easily replace a module such as the rf with his own creation instantly for direct comparison. This standardization would drastically reduce the development costs of new equipment. Manufacturers could concentrate on building better and less costly modules to perform the many different functions various hams desire. It would drastically reduce the problem of converting to other uses, such as MARS, military, RTTY, TV, or whatever, simply by plugging in the appropriate modules.

Figure 3 is a block diagram of a crystal-controlled 3–30 MHz transceiver for AF MARS presently under construction with this approach. As an example, Fig. 4 is a photograph of the component side of a complete 9 MHz SSB transceiver on a small printed circuit board. One LM-173 integrated circuit serves as a complete SSB/CW receiver with 9 MHz input and audio output with avc. The other LM-173 integrated circuit is an SSB/CW generator with 50 mV audio input and 9 MHz SSB output with alc. A McCoy filter is mounted on the

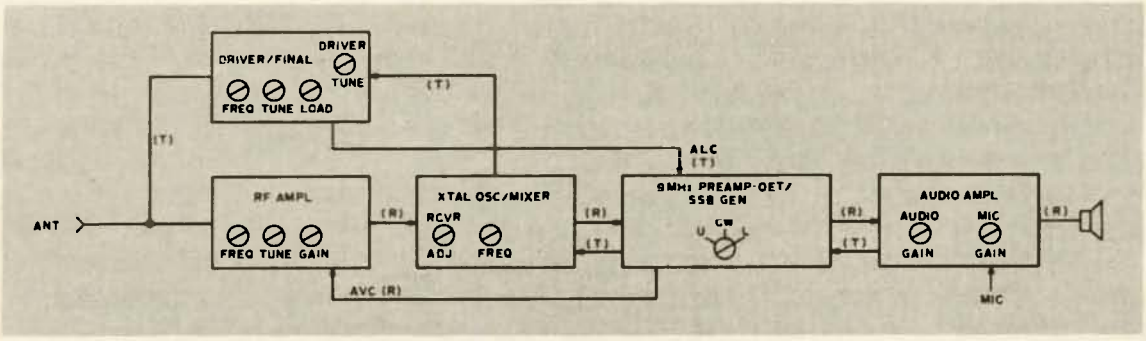
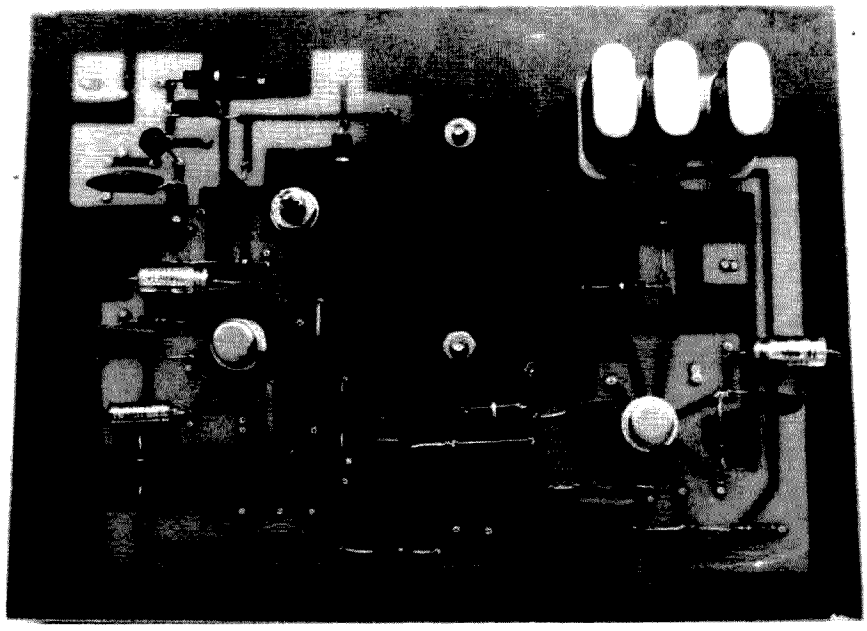


Fig. 3. Block diagram of A. F. Mars transceiver.

other side of the board for maximum isolation. The board could have been made much smaller, but I like lots of room between components for better isolation in such circuits. With the use of ICs and functional isolation, small, compact, and inexpensive modules may be constructed.



Component side of a 9 MHz SSB transceiver.

In order to make this approach work, some agreements must be reached. I might suggest the following: Although most of these circuits will be solid state, room should be left for those who prefer tubes. Actually, most of the space requirements are dictated by control functions and connectors, not the circuits themselves. In order to prevent the need for expensive, complex controls, a fair amount of front panel space should be available. At any rate, for what they are worth, here are my recommendations:

Front panel space: 16" wide x 6" high.
Module width: 2" single, 4" double, etc.
Power connectors: Blue Ribbon 24 pin every 2"
Module depth: 6" – Rack depth: 8"
Rf signal connectors: BNC
Power supply connections:

Pin: 1 ground	13 alc
2 +24 vdc	14 avc
3 +12 vdc	15 ground
4 ground	16 ground on transmit
5 6.3 ac	17 ground on receive
6 6.3 ac	18 receiver audio
7 ground (6.3 ac return)	19–24 spares
8 -100 vdc	
9 ground	
10 +150 vdc	
11 +250 vdc	
12 ground	

These pins are simply "reserved" for these voltages. They need not be supplied if not needed. For all solid state units, it is recommended that only the +12V be used so mobile operation may be used easily. Final high voltage to final (+750V) is supplied to that mobile on a separate connector.

Anyone could get into the communications equipment business by simply producing the racks first. Then they could add module chassis, power supplies, and modules as they grew. Fierce competition would drive prices down eventually, however, and should result in high quality, very flexible equipment at much more reasonable prices. System design costs would virtually disappear. Testing costs would also be reduced drastically, and fault isolation for the average ham much easier.

All in all, I feel it is the ideal approach to low cost, high quality, communications equipment, which can be assembled simply to perform any desired functions within the desires and budget of each user. It should also stimulate a lot of interest in homebrew to see if we can better the commercial boys and build a better "mousetrap" without undertaking a whole major project at once, thus improving our technical ability piece by piece.

. . . K9ALD ■

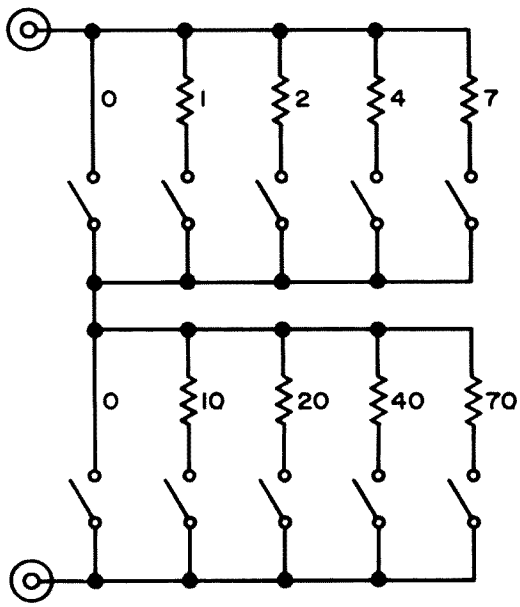


Fig. 3. Toggle switches and additional resistors extend the H decade.

Place panel on brackets in box and spot bracket holes. Remove panel and drill holes and tap with 6-32 tap. Eventually, attach panel to box with 6-32 x ¼ in. machine screws.

Finishing the Box

The schematic and the operating instructions should now be attached under the box and inside the lid. The box should be identified on the outside front with the name of the test equipment it houses, and the builder's call letters placed in the lower right corner.

Figure 1 shows a basic series resistance decade. It is made up of nine identical values of resistance, each of which can be calibrated to a single high-accuracy resistance. It is easy to build, as all the resistors can be soldered directly to the rotary switch. However, since it does require a greater quantity of resistors throughout, it could double the cost.

Another type of resistance decade is the H configuration of Fig. 2. This uses only four resistors mounted on a small subpanel. Note that the R1, R2, R4, and R7 values are used individually, but the other values are combinations of two resistor values. The connections are marked A to E; wires run between these points and the switching shown in Figs. 3 and 4. Figure 3 shows a dual decade resistance which uses ordinary toggle switches.

You will note that we have not talked about what the specific resistance values should be and what wattage resistors should be used. If you use composition resistors, it is suggested that 2W types be

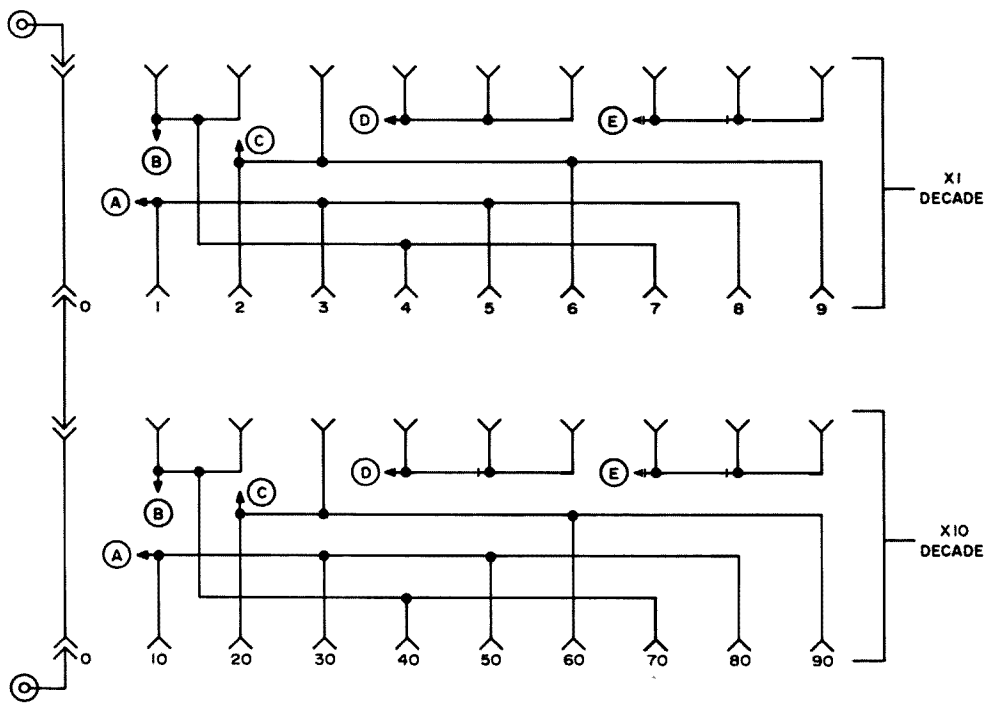
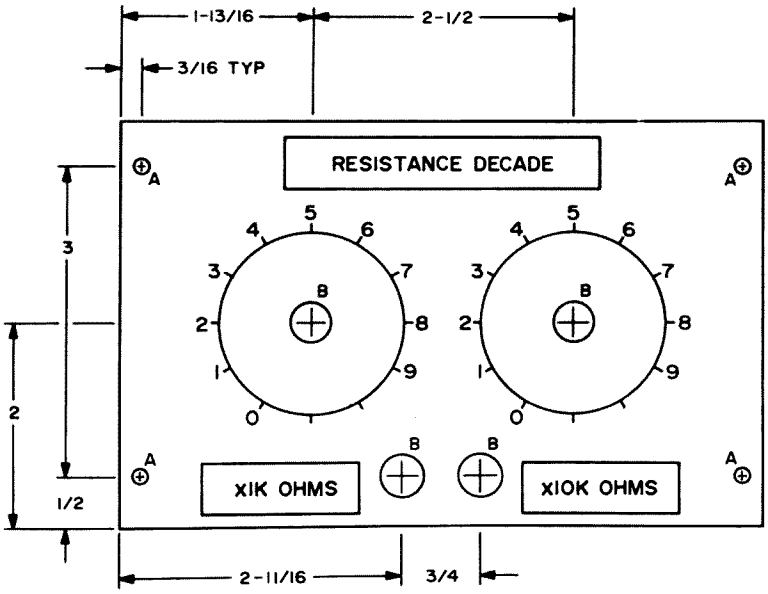


Fig. 4. Rotary switch connections for a dual decade.



HOLE CHART		
SYM	DRILL SIZE	QTY
A	NO. 25	4
B	3/8	4

Fig. 5. Panel layout for the file box unit.

used. As far as the resistance values are concerned, they will depend upon the total resistance required of the decade. For instance, a 100 kΩ decade would be composed of a 10 kΩ, 20 kΩ, 40 kΩ, and 70 kΩ.

It is suggested that you make up your first dual decade file box with 10 kΩ and 100 kΩ decades. Then build another with 100Ω and 1 kΩ decades. This should cover the largest part of the resistance requirements. Other values, of course, can be used, but watch the added circuit resistance with low decade resistances.

The second switching method for the H configuration is the rotary switch shown in Fig. 4. This is the configuration shown in the photo. A panel layout is shown in Fig. 5. The panel markings shown for the various switch positions on the panel can be accomplished with metal escutcheons, as shown, or with dry transfers such as obtained from Datamark.

Accuracy

It is self-evident that resistors should be as precise as your pocketbook can afford. Why not start out with 5% composition resistors and when you run across more accurate values, just substitute them. One way to get the accuracy better, and by as much as an order of magnitude is to use paired resistors of twice the value, and in parallel.

If you can beg or borrow the use of a good resistance bridge, you can calibrate the resistors quite accurately by taking two resistors in parallel, and by picking the resistors, come out with rather good accuracy. First calibrate each resistor on the bridge, separating them into two piles, those plus and those minus the resistance value which is just twice the desired value. Then set the bridge to the final desired value and match plus and minus values until you get two that hit the correct value.

Just one caution: When you solder composition resistors, treat them as you would a transistor. They can permanently change value due to too high applied heat. Use a pair of pliers as a heatsink between the resistor and the hot soldered joint.

When you have installed the panel in the specially worked file box, attached the schematic to the bottom and any information, such as calibration dates and accuracies, you will have a compact, useful test instrument that can help you a great deal in your ham building.

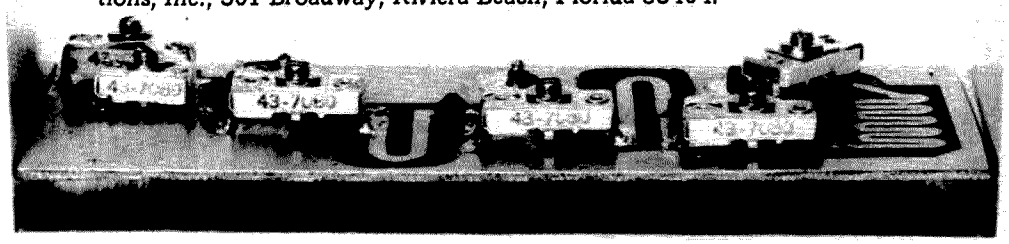
File Box Parts List

(1) file box
(2) pieces of ½ in. aluminum bracket (4 in. lengths)
(4) rubber feet with 6-32 mounting screws and nuts
(1) panel, aluminum (6-1/8 x 3-15/16 x .030 in.)

. . . WB4ITN ■

Editor's Report:
The DyComm 15W 2 Motor Mini-Amplifier

The DyComm 101—500 rf amplifier is a product of Dynamic Communications, Inc., 301 Broadway, Riviera Beach, Florida 33404.



There's a brand new miniature rf amplifier being marketed that should be of considerable interest to both builders and the QRP boys alike. The unit is small enough to fit into your pocket, and can whack out a signal of up to 15 watts with less than 80 mW of drive. For FM applications in particular the tiny amplifier should prove extremely popular. To get it going, all that is required is to apply a 12V dc power source and feed in a low-power FM signal. Then presto, a 50 mW handie-talkie becomes a full-powered mobile.

General

This sophisticated little piece of machinery is called the DyComm 101-500. It was originally developed as a module of a compact commercial radiotelephone unit, and it is currently in use in that service. Considering the fact that the rf amplifier designed for the commercial application was reliable, efficient, self-contained, and extremely broad-banded, someone got the bright idea of making the units available to amateurs.

Not that the frequency of operation can't be changed; it can – by the simple expedient of adjusting a few variable capacitors. But as it comes from the factory, the amplifier is tuned to the center of the 2 meter band. The curve of resonance is so broad that the half-power points (without tuning) are a full three megahertz either side of the center frequency.

According to the manufacturer, the DyComm's main claim to fame is its remarkable cleanness of signal. Harmonic content is so low that no feedback coupling was used in the design. This exceptional performance is partially attributable to the low-Q coupling used in the collector and base circuits between stages. With a sufficient number of stages to assure high efficiency and plenty of gain without excessive drive, each stage's input level is limited by very low-Q rf chokes The philosophy seems to be "the lower the drive, the less the chance of harmonic radiation."

The unit that was submitted to 73 for evaluation was reportedly right off the production line. All I needed was a low-power rf source and an auto battery of some other source of dc. I just happened to have an HT-100, a pocket sized transceiver made by Motorola that puts out 100 mW of rf on 2 meters FM. For power, I used an Eico 10A variable dc power supply.

Since the DyComm requires only 20 mW to drive it, I coupled the Handie-Talkie's signal into the unit with nothing more than a clip lead attached to the telescoping antenna. I connected the DyComm output through a Bird Thru-Line wattmeter to a 2 meter groundplane, hooked up the dc power, and pressed the push-to-talk switch. Immediately, the Bird indicated a power output of just under 12W. I increased the dc supply voltage to 15V and trimmed the final a bit and the output climbed to 15W.

I don't know how much rf power I was putting into the DyComm, but the manufacturer's specifications stated that the input range should be somewhere between 20 and 50 mW. I can assume I was in the general ballpark because my HT is only rated for 100 mW at best and there was bound to be a substantial signal loss because of my hokey coupling method.

The Circuit

As shown in Fig. 1, the circuit consists of three rf stages connected in cascade. The complete amplifier is built onto an epoxy–fiber-glass circuit that is nestled within the confines of a heatsink "surround." Large-signal impedance values were used in calculating input–output matching requirements, and L-type matching networks are employed in coupling. The result, according to the manufacurer, is optimum transfer of signal at the stated input and output impedances (50Ω), and maximum stability.

Another factor adding to the units' stability is the minimizing of unwanted inductances through multiple emitter contact on the driver and final transistors. The emitters in these stages are internally connected to the semiconductor case. Thus, when the transistors were inserted into the circuit board, a solder connection was made to the transistor case as well as to the emitter lead itself. This may seem like a small thing, but many engineers have gone through many hair-pulling hours trying to solve problems that could have been solved with the same simple technique.

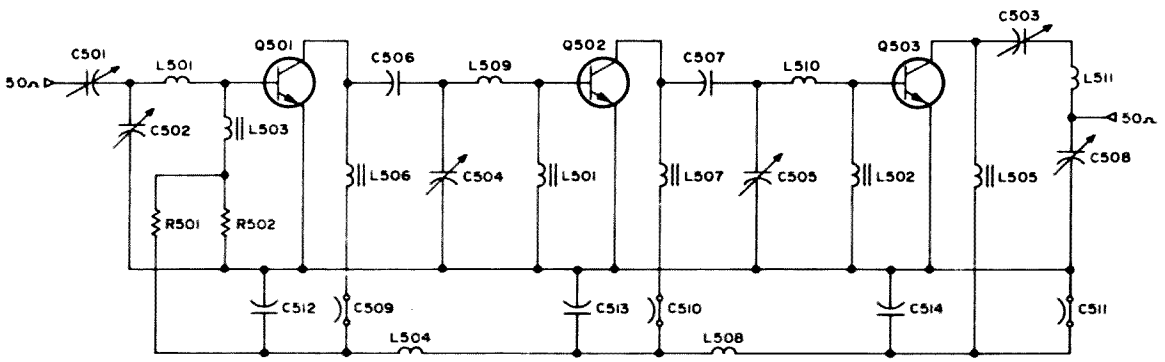


Fig. 1. Complete schematic of the DyComm 101-500 rf power amplifier. Total gain of the three-stage unit is 25–30 dB, depending on drive and supply voltage.

The overall gain of the amplifier is about 28–30 dB. The first stage gain is 12 dB; the balance is equally divided between the second and final stages. If signals greater than 20–50 mW are to be coupled into the amplifier, the first-stage gain can be reduced by lifting R502. If signals greater than 500 mW are to be amplified, the signal should be coupled directly into the second stage.

Performance

Figure 2 shows how the DyComm rf amplifier is interconnected in actual use.

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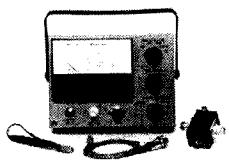
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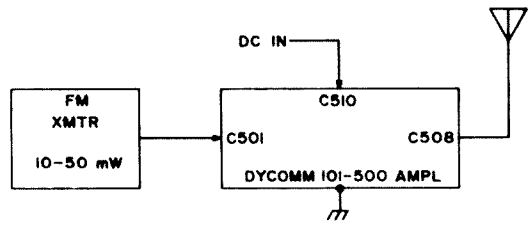


Fig. 2. This sketch shows how the DyComm rf amplifier is interconnected for operation. The capacitor numbers depicted are tie points.

Since the amplifier can be classed as a class C type, it accepts CW or FM directly. With some modification, the circuit can be linearized to accept AM signals, too; the manufacturer can supply all the information necessary to do this.

The tables below list the actual measured output power at various dc input voltages. Table I gives performance figures for an rf drive of 25 mW. Table II shows performance with 35 mW of drive.

Table I. DyComm Performance Values at an RF Input of 25 mW.

Supply, VDC	Primary Current, A	RF Output, W
10	0.35	0.4
12	0.5	1.4
14	0.8	3.0
15	0.9	4.4
16	1.1	6.0
17	1.25	8.3
18	1.45	11.0

Table II. DyComm Performance Values at an RF Input of 35 mW.

Supply, VDC	Primary Current, A	RF Output, W
6	0.55	1.5
8	0.80	3.0
10	1.0	5.4
12	1.25	8.0
13	1.45	10.5
14	1.5	12.0
16	1.8	16.0
18	2.1	20.0

. . . K6MVH ■

STUDY GUIDE GENERAL CLASS LICENSE

PART IIB

In the first half of this part of the study course we determined that *resistance* and *reactance* could be considered as forms of *impedance* – which helps us understand why the ohm can be the common unit of measure.

But what about the effects of impedances, such as rf resistance, skin effect, and other resistive and inductive phenomena? In the first part of this series, we mentioned a definition of inductance based on the "number of flux lines" encircling the current flow, to show what happens.

Consider a piece of straight copper wire, such as that sketched in cross-section view in Fig. 10. (The figure numbers are continuations of those in Part IIA.)

If we push dc through this wire, from a battery, current flow will be approximately the same throughout the cross section of the wire. Just as much current will flow near the center as flows in the same cross-sectional area near the edge.

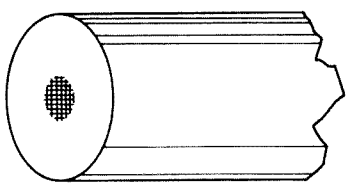


Fig. 10. Cross-section view of copper wire shows how center portion of wire is surrounded completely by conductor, while surface region has conducting material only on one side of it. This causes center to have more inductance than surface, which will in turn force ac current to seek the surface and avoid the center. The higher the frequency of the ac, the less effective will be the interior of the wire. At sufficiently high frequency, all current travels on the "skin" and almost none flows in the interior. This is called "skin effect."

That current in the center is surrounded by the magnetic field associated with itself, and also by the magnetic field associated with all the current in the outer parts of the wire, while the current on the wire's surface is surrounded by magnetic field from only itself and adjacent currents.

This means that there will be, inherently, more inductance in the center of the wire than on its surface. With dc, it makes no difference, because inductance is a factor only when current flow is changing.

With ac, the resulting inductive reactance means that the wire's impedance is lower on the surface than it is in the center. So long as signal frequency is low enough, the effects are not noticeable. At radio frequencies, though, the effect becomes appreciable. Virtually all the current is flowing near the surface of the wire, and the center might as well not be there. This variation of impedance between the surface of the conductor and its interior is what is known as "skin effect," because the rf current seems to flow on the "skin" of the conductor and avoid the interior.

No harm is done by the copper on the inside of the wire, but in high-power circuits it's often more economical to use hollow tubing rather than solid rod, and because of the skin effect one works as well as the other. It's not unheard-of to find really high-power rf coils being cooled by water pumped through the hollow cores of the conductors!

One way in which "skin effect" is minimized at moderate frequencies is by using "litz wire," which consists of many individual conductors, each insulated from the other, and woven together in such a manner that each individual conductor spends as much time in the high-inductance center of the combined strand as it does on the surface. This equalizes the inductance for all conductors, and effectively connects all of the reactances in parallel so that it does actually reduce the rf resistance. At high frequencies, however, the principle breaks down because the variation of conductor position cannot be made to happen

within a short enough distance as compared to the signal wavelength.

Litz wire, like all the other combining of reactances we've touched upon so far, involves the combination of the same type of reactance. What happens when we combine the two different types of reactance? That's our next subject.

What Is Resonance? Back near the beginning of our preceding discussion, we mentioned in passing that it was possible to use a little reactance of one kind – say inductive – to cancel out some of the other kind – in this case, capacitive.

Now let's take full advantage of this fact, with the series circuit shown in Fig. 11

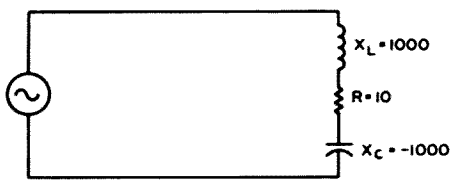


Fig. 11. Series L-C-R circuit illustrates effects of resonance, which is possibly the most important single phenomenon aside from energy propagation itself so far as radio operation is concerned. Resonance permits "tuning" of equipment to select one frequency and reject all others, which in turn makes it possible for more than one transmitter to be used at one time. Without tuning, radio as we know it would not be possible.

which contains an inductor, a capacitor, and a resistor, all in series with each other.

We know already that the resistance of the resistor will be the same at all frequencies, and that the reactances will change as the frequency changes. Let's plug in some specific figures to see how this circuit can be expected to behave. For instance, let's make the resistor 10 ohms. Reactance of the inductor will vary with frequency, being much less than 10 ohms at frequencies near zero Hz, and being in the megohm region at extremely high frequencies. Similarly, the capacitors reactance will vary from a very high value at low frequencies, to only a few ohms at high frequencies.

Notice that where the inductor's reactance is small, at the low frequencies, that of the capacitor is large, and vice versa. It stands to reason, then, that at *some* frequency within the infinite range possible, their reactance must be equal.

Let's assume that we have picked proper values for both capacitor and inductor to make this happen when the inductor's reactance is +1000 ohms; the capacitors's reactance is then -1000 ohms.

But since the reactances are equal in value and opposite in sign, they cancel each other cout completely – and the resulting circuit impedance is that of the resistor alone, or 10 + j0 ohms (10 ohms at 0°, if you prefer the single-value method of rating impedance).

This might be only mildly interesting, except that the opposite kinds of reactance both tend to keep circuit impedance high at other frequencies. Take for example the frequency which is only 1/10 that at which the values cancel at 1000 ohms each. At this new frequency, the inductance is only +100 ohms, and the capacitor is up to –10,000 ohms, which gives us a net reactance of -9,900 ohms. Circuit impedance is 10 - j9900 ohms, or in the single-value method, 9900.5 ohms at -89.5° approximately.

Going in the other direction, at the frequency 10 times that at which the values cancel, the inductance is up to +10,000 ohms and the capacitor is down to -100 ohms, which gives a circuit impedance of 10 + j9900 ohms or, in single values, 9900.5 ohms at +89.5 degrees.

If our circuit is fed by an ac source which provides the same voltage – say 99 volts – at all frequencies, then at either the high or the low frequency only about 1/100 ampere of current will flow through the circuit. But at the single frequency where the reactances cancel, current will be limited only by the resistance and in this case the current flow will be 9.9 amperes. That's 990 times as much as at either the high or the low frequency.

In this manner, the series L-C-R circuit of Fig. 11 selects current at a single specific frequency and permits it to flow through, while tending to block current at all other frequencies either higher or lower.

And that's the particular function which is necessary in order for us to be able to

choose a signal at one frequency and reject those at other frequencies. For this reason, this circuit and its close relatives are among the most fundamental circuits in all of radio.

The condition in which reactance is completely cancelled out of the circuit is known as "resonance," and a circuit in which all reactance is cancelled out in this manner is called a "resonant circuit." The particular resonant circuit shown in Fig. 11 is known as a "series resonant" circuit, because its driving source is in series with all circuit elements.

The impedance of a resonant circuit depends upon a number of factors, but they are lumped into two general headings. One is the frequency of the applied signal, and the other is the "Q" factor which we will be examining shortly. Figure 12 is a

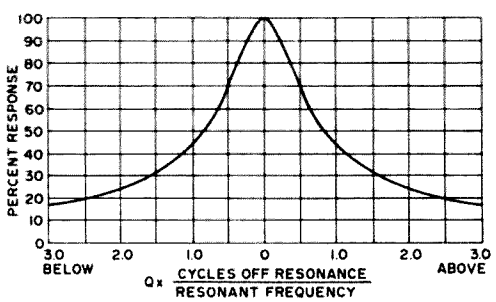


Fig. 12. Response curve of any resonant circuit is shown here. Horizontal scale is dependent upon two factors, "Q" and "resonant frequency," which makes this graph universal. For example, a resonant circuit with a Q of 100 and a resonant frequency of 10 kHz would make the horizontal scale come out to be 100/10000 times cycles off resonance, or 0.01 times cycles. At a frequency of 10.01 kHz, 100 cycles above resonance, the value to use on the horizontal scale would be 0.01 times 100 or 1.0, and response would be 45 percent of that at resonance.

graph of a "universal" resonance response curve; the solid line can be thought of as representing current flow through the circuit of Fig. 11 as compared to maximum current flow at resonance.

In addition to the series resonant circuit, we also make use of "parallel resonant" circuits. Parallel resonance was at one time called "antiresonance," but this word is rather rapidly fading from use. Figure 13 shows a parallel resonant circuit.

If we ignore the power-source connections in Fig. 13 we will see that the reactances and the resistance are still in series with each other. The difference between parallel resonant circuits and

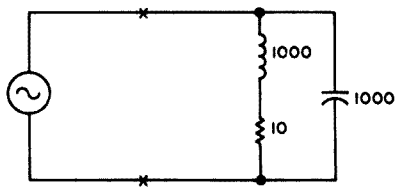


Fig. 13. Schematic of typical parallel-resonant circuit. If power source is disconnected at points marked "X" and circuit is then opened at any point, it becomes same as series-resonant circuit of Fig. 11. Resistance is shown here in series with inductor because in practice, inductors usually have more stray resistance than do capacitors and circuit behaves as if all resistance were in the inductive leg. See text for details of circuit action.

series resonant circuits depends on the way in which the power or driving source is connected. If the source is in series with the reactances, it's series resonant. If the source is in parallel, it's parallel resonance.

The impedance characteristics of a parallel-resonant circuit are markedly different from those of series resonance. In series resonance, circuit impedance is high except at the resonant frequency. In parallel resonance, though, the reactances are in parallel so far as the power source is concerned, and this means that rather than cancelling out reactances, we must combine "susceptances." High reactance means low susceptance, and vice versa.

At low frequencies, the inductor has low reactance and high susceptance, while the capacitor has high reactance and low susceptance. The capacitor's low susceptance cancels out its corresponding amount of inductive susceptance, but the remaining susceptance is still high which makes net reactance low.

At high frequencies, it's just the other way around, and net reactance is still low.

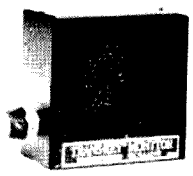
At the resonant frequency, the two susceptances are equal, and so they do cancel each other out. But a susceptance of zero is equivalent to an infinite impedance. This means that at its resonant frequency, a parallel-resonant circuit must have very high impedance. At other frequencies, the impedance depends upon the reactance left over after cancellations.

Why is the impedance so high at resonance? This happens because each reactance, individually, enforces aphase shift between voltage and current. The capacitor puts voltage 90° behind current, or current 90° ahead of voltage. The inductor puts current 90° behind voltage. Since the circuit is parallel, voltage across both reactances is identical at all times. But since current in the capacitor is 90° ahead of this voltage while current in the inductor is 90° behind, the phase difference between the two currents is 180° – and this amounts to a complete cancellation of current flow.

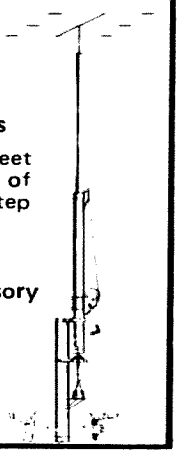
The "cancellation" is effective only so far as the power source is concerned. In each reactance, its own current is flowing. However, this current cannot get out of the circuit – and so it circulates between inductor and capacitor. It's known as "circulating current," and is very real indeed as anyone who has watched the output coils of his transmitter melt from its effects can testify!

The circulating current is, in fact, as much *larger* than the current which either reactance alone would permit to flow, as the actual current flow is smaller. Both are related to the circuit's "Q" as we shall shortly see.

Because the circulating current *is* larger, a closed resonant circuit in which circulating current flows can act as a voltage amplifier. The circulating current through each reactance will produce a voltage drop determined by the amount of current circulating and by the reactance value. If the driving power is coupled into the circuit by means of a tap on the inductor, it can force large circulating currents, and an output voltage much larger than the input voltage can be obtained. This isn't something for nothing, because no *power*


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gain is achieved. The higher voltage can only be obtained if little or no current is taken from the circuit. Many receiver input circuits make use of this fact to help overcome effects of tube and circuit noise, by stepping up signal voltage ahead of any amplifier stages.

To determine the exact frequency at which any specific pair of inductance and capacitance values will be resonant, we just combine the inductive-reactance and the capacitive-reactance formulas and come up

$$F = \frac{1}{2\pi\sqrt{LC}} \qquad F^2 = \frac{25{,}330}{LC}$$

Fig. 14. Equations for resonant circuits. Version at left is basic formula, with frequency in hertz, inductance in henries, and capacitance in farads. That at right is practical version with frequency in megahertz, inductance in microhenries, and capacitance in picofarads. For any value of inductor, some capacitor exists to make it resonant at any desired frequency. In practice, choices are also limited by effects upon circuit Q and feasibility of actually obtaining desired values.

with the equations shown in Fig. 14. As before, one is exact and the other is more practical, having all the conversion factors and the "pi" constant built into a single magic number. While any specific pair of values will have only one resonant frequency, in theory any inductor can be resonated at any desired frequency by simply choosing the proper capacitor value, and vice versa. In practice, "Q" is also a factor to be reckoned with and tends to limit the choice of L and C values.

All through this discussion we've had to refer to "Q" from time to time. Let's find out now just what this strange factor is, and what its effects are.

What Is Q? "Q" is a symbol which shows up in radio theory just about as often as do the "R" which stands for resistance, and the "E" for voltage, the "I" for current, the "L" for inductance, or the "C" of capacitance. You'll meet "Q" as part of the description of nearly any coil, many capacitors, and all tuned circuits. It is used to describe the characteristics of quartz crystals, and of antennas. But what is it?

The symbol "Q" originally stood for "qualify factor," and almost all textbooks define it in the same say – as the ratio of inductive reactance to total resistance in a circuit (X_L/R). But very few texts bother to show why the ratio of reactance to resistance should be of much importance, and only a couple of the more than a dozen we studied in preparing this discussion bothered to give any other definition of Q.

Nevertheless, Q *is* important, and it has many definitions, all are equally true in every case, but for any special case, some are easier to apply than others.

So let's try to see first why the ratio X_L/R affects behavior of a resonant circuit, and then explore some alternate definitions of Q. We'll begin by returning to our series-resonant circuit shown in Fig. 11, with the same component values used before. That is, 10 ohms resistance and 1000 ohms reactance for each reactance.

We discovered already that if this circuit is driven by a power source which delivers 99 volts peak, a peak current of 9.9 amperes will flow through each of its three elements.

What we failed to say before is the fact that we can determine the voltage across either the coil or the capacitor alone, either by Ohm's Law or by actual measurement with a good VTVM. Here, we'll do it with Ohm's Law in the form E = IZ.

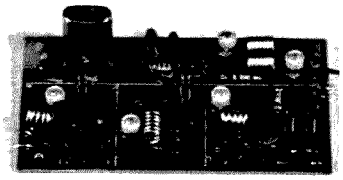
Since it's a series circuit, I is the same for all three elemtnts, or 9.9 amperes with our 99-volt source. Impedance of the coil is 1000 ohms at 90°, and so the voltage across the coil must be 9.9 times 1000, or 9,900 volts at 90°. Impedance of the capacitor is also 1000 ohms at -90°, so its voltage must be 9.900 volts also, but at -90°. Since these two high voltages are 180° out of phase with each other, they cancel each other out and cannot appear to the external circuit – but inside the circuit, measured across each element by itself, they're present.

Some authorities call this action the

FET CONVERTER KITS FOR 50, 144 AND 220 MHZ

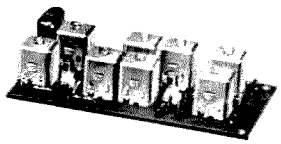
Basic two-meter converter described in February 1969 issue of VHF COMMUNICATIONS. The most popular VHF converter in Europe! Hundreds already in use in North America.

Kit contains: Glass-epoxy p.c. board (silverplated), crystal, coil forms and trimmers. Requires additionally: Three FET's (TIS 34, MPF 107, etc.), two bipolar transistors (TIS 45, etc.), coil wire, fixed capacitors and resistors. IF 28–32 MHz. 12 VDC/16 mA. Noise figure (attained with MPF 107's) 50 MHz: 2, 144 MHz: 2, 220 MHz: 2.5.



Kit price $10.20 each.

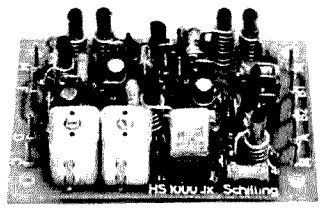
DUAL GATE MOSFET CONVERTERS FOR TWO METERS



Low noise figure (<2). Excellent cross modulation and image rejection (116 MHz xtal oscillator). IF 28–30 MHz. 12 VDC/20 mA. Silver-plated, glass-epoxy p.c. board. All inductors shielded. Fully assembled and aligned. By Braun.

Model DGTC 22, $35.00

Highly compact converter (3" x 2" x 1"); can be mounted in existing receiver or transceiver cabinet. Electrical characteristics as above, except any IF between 14 and 32 MHz can be selected by simple plug-in of the appropriate oscillator crystal. (116 MHz crystal furnished with converter). Oscillator-emitter follower output for use with transceiver.



Schilling Model HS 1000 Jx, $ 39.50

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"voltage magnification" of the resonant circuit, and speak of the 9900/99 ratio between reactive voltage and applied voltage as the "magnification factor."

Others call the ratio the "quality factor" or merely "Q."

The relation between this "magnification factor" and the definition of Q as being X_L/R is not overly obvious. It comes about because each of the voltages – that across the reactance and that across the total circuit – is related to the same series current by Ohm's Law. In both cases, E = IZ, where Z is the impedance and I is the current.

For the reactance, the Z is equal to X_L or X_C, and at resonance they're the same absolute value. For the total circuit, both reactances cancel out and the impedance is simply R. The voltage ratio E_x/E_t then becomes IX_L/IR; the I cancels out of the calculation since I/I is always "1," leaving us only X_L/R to define the magnification factor or Q.

Now let's see why "Q" should be such an important factor in the first place.

One of the most important uses of "Q" is as a measure of the effectiveness of a resonant circuit. That is, it measures how effectively the circuit can separate two signals of different frequency. We can demonstrate the relation between Q and selectivity in two ways, one of which is easy to see and the other of which, though much more accurate, requires more thought. Let's try both, the simpler one first.

Recall that the selection capability of a series resonant circuit comes about because at the resonant frequency, current flow is limited only by the R of the circuit, while at frequencies far from resonance, the X is the limiting factor and the R has very little effect.

This means that if the resistance is very small compared to the reactance at the resonant frequency, the current flow at resonance will be very high compared to current at those frequencies where the reactance is the limiting factor.

If we increase the resistance and leave reactance alone, it will have little effect on current at the extreme frequencies, but will

reduce the current flow at resonance. Thus the ratio between current at resonance and current far from resonance will become smaller, and the circuit is therefore less selescive.

Since Q goes down as resistance goes up, if X is constant, this means that a high-Q circuit must be more selective than one with low Q.

While this explanation shows how circuit Q affects selectivity in general, it unfortunately does not tell us much about what happens at frequencies near resonance. To find out how Q works in this region – which, after all, is the one in which we are most often really interested – we must go to the more detailed explanation. It takes a little arithmetic to illustrate.

We define Q by looking at the "magnification factor" – the ratio between the voltage across either reactance, and the total voltage applied to the circuit.

At frequencies near resonance, the reactances will not vary greatly from their values at resonance. If our inductor has 1000 ohms reactance at 10,000 Hz, then at 10,010 Hz its reactance will be 1001 ohms, and at 9,090 Hz it will be 999 ohms. The capacitor will behave similarly, with reactance values of -999 ohms at 10,010 Hz and -1001 ohms at 9,090 Hz.

Because of the mutual cancellation of opposite types of reactance, the net reactance of the circuit will be the difference in reactance values. At 10,010 Hz, net circuit reactance would be 1001 - 999, or 2 ohms inductive.

If our circuit had a Q of 100, this would mean a resistance of 10 ohms (and with a 100-volt-peak source, 10 amperes current flow at resonance). Impedance of the circuit at 10,010 Hz, then, would be 10 + j2 ohms, or about 10.19 ohms at a very small phase angle. Current flow at this frequency (E/Z) would be 100/10.19 or about 9.84 amperes, nearly as much as the 10 amperes at resonance.

If we leave the reactances alone, but reduce the resistance to only 2 ohms, we will raise circuit Q to 500 (1000/2). Current flow at resonance would be 5 times as great, or 50 amperes with a 100-volt source. At 10,010 Hz, however, circuit impedance would not be 2 + j2 ohms, or 2.83 ohms at 45°. Current at this frequency would be 100/2.83 or 35.4 amperes. This is only 35.4/50 or 70.8% of the current at resonance, while with a Q of 100 the currents at the two frequencies were almost equal.

The same thing happens at all other frequencies, whether near to or far from the resonance point of the circuit. The result is that a high-Q circuit is "sharper" than one of low Q. Figure 15 shows this by

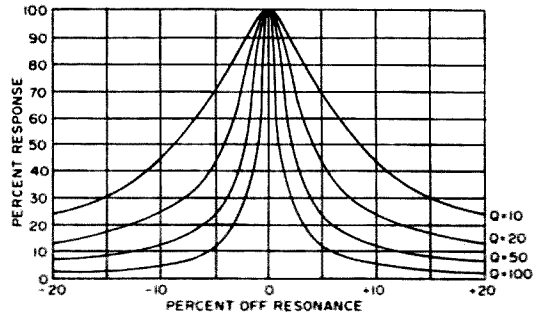


Fig. 15. Effect of Q upon circuit selectivity is shown graphically. This is similar to Fig. 12, except that factor "Q" has been removed from horizontal scale and different curves have been drawn for different Q values. The greater the Q, the sharper the selectivity. Notice that effects are greatest in regions near resonance, but very little difference exists at frequencies almost exactly on the resonant frequency.

comparing relative currents for circuits with Q's ranging from 10 to 100, for frequencies from 20 percent below resonance to 20 percent above.

Of course, instead of measuring current flow through the circuit directly, we could take the voltage developed across either reactance, because this voltage is developed by the current flow through that reactance. And, in practice, this is exactly the way in which a receiver makes use of resonant circuits. The output of the circuit is usually the voltage developed across the capacitor.

The ratio X_L/R is the most commonly encountered definition for Q, but it's not by any means the only one nor is it even the most descriptive. Our own favorite is

one which defined Q as being proportional to "the ratio of peak energy storage to average power loss" in any circuit.

This definition is directly related to the more familiar one, because the circuit's reactance is a measure of peak energy storage while the resistance includes any factors which actually *lose* energy.

However, thinking of Q as a ratio of energy stored to energy lost makes it apply to many non-electrical things, such as a swinging pendulum or a vibrating tuning fork, while the terms "reactance" and "resistance" are limited by definition to electrical actions.

Q is sometimes defined as being the inverse (or reciprocal) of the "power factor" of a component or circuit. The "power factor" is the ratio of power consumed to apparent power, which boils down to being a ratio of resistance to reactance. Since this is the inverse of the ratio which defines Q in the most common definition, defining Q as the inverse of power factor is simply a second-hand way of providing the same definition.

Q is also sometimes defined – and frequently measured – by its effect on bandwidth of a circuit. In resonant circuits having Q's in the normal range (from 10 to 1000,) the number of Hz between the half-power points (the two frequencies, one above and one below the resonant frequency, at which power transfer falls to half of that transmitted at resonance) are related to the resonant frequency by a factor which is roughly 1/Q.

That is, for a Q of 10, the lower half-power point will be f/10 Hz below the upper one, if "f" is the resonant frequency in Hz. If Q is raised to 20, the separation or "bandwidth" will be f/20 Hz, and with a Q of 100, it will be f/100 Hz.

All of our discussion of "Q" so far has been in terms of series resonant circuits. It applies equally, though, to parallel-resonant circuits by making proper substitutions. The net result after these substitutions are made is that the circuit impedance, rather than voltage, is multiplied by Q. That is, in a parallel-resonant circuit each of whose reactances is 1000 ohms at resonance and having a Q of 100, the impedance at resonance will be 100,000 ohms at 0°.

If such a circuit is then "loaded" by connecting a perfect 100,000-ohm resistor across it, the net impedance will be reduced to 50,000 ohms. The same result would be produced by raising the internal resistance from 10 to 20 ohms and so lowering Q to 50. In most radio theory the effects of such "loading" are accounted for by assuming that the load is "transformed" into the equivalent series resistance. In this case, the 100,000 ohm resistor's value would be transformed to 10 ohms, and its effective connection point would be changed from being in parallel with the resonant circuit to being in series with the inductor inside the circuit.

This is what is meant by the "impedance transformation" effects of a tuned circuit, and transmitters make use of tuned circuits in this way to large degree.

We said way back at the beginning of this discussion that Q is applied to such things as quartz crystals and antennas, as well as to conventional resonant circuits. In these cases, the "energy stored/energy lost" definition is the most meaningful one.

A crystal, for instance, will vibrate for some time after receiving a single impulse, and this vibration will in turn return electrical energy in the form of mechanical vibrations and returns it with little loss. This means that the "Q" of a crystal is remarkably high (around 25,000 for most ham units).

An antenna, on the other hand, is intended to radiate or lose as much energy as possible, so that low Q is desirable for any antenna. Many designs, however, will radiate effectively only over a narrow range of frequencies, and at all other frequencies will store the energy rather than radiating it. This means that the Q goes up, and the designer must find ways of lowering the antenna Q.

Next Time. Now that we have fairly firm foundations established both for ac and dc circuit theory, we can go into the superstructure. Our next installment will examine power, decibels, and harmonics.

. . . Staff ■



What Really Happened To Hamdom?

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Incentive programs or not, this article is hardly expected to endear the writer to the hams in this country—nor, perhaps, to the policy-making editors of *73*. It is designed instead to inform hamdom of some serious problems that have been all but ignored in recent years. Let it be stated now that what follows are the impressions and opinions of the author, combined with known facts gleaned from the general public, the electronic industry, and from current legislation and trends in Washington, D.C.

We challenge readers to dispute these truths; we implore readers to reexamine themselves and make an honest effort towards maintaining the open-mindedness this hobby needs.

The draft for this diatribe began as an article devoted to informing our meager readership of the pros and cons of QRP. Before I realized, however, I had struck a tender root of one of the most serious problems American amateurs face today. But we are getting ahead of our story.

In an attempt to get a truly objective perspective regarding the state of ham radio today, I stumbled across an item of profound implication in the foreign ham press. Smatterings of information on low-power and QRP associations have appeared from time to time in the recent past in this country, but there remains the fact that a great deal of amateurs here don't even know what QRP means, much less the thinking behind it. So what?

Shortly after the last war, amateurs in almost all other countries began to seriously investigate the advantages of running on reduced power. In London the QRP Society, Inc., was formed to keep Europeans abreast of flea-power military surplus bargains while at the same time serving to further awaken hamdom to the exciting world of QRP. What caused this interest in "half-hearted" hamming? Economics. The flow of surplus equipment into European markets meant that with the proper knowledge, an SWL could get on the air without investing large sums of

money. In short, the expense of becoming a ham had been substantially lowered, and with it came a remarkable increase in the number of foreign amateurs on the air. Understanding this important factor, it is relatively simple to see why the QRP trend caught on like wild fire overseas.

While progressive European countries experimented with single-tube transmitters and later developed transistorized 144 MHz transceivers, Americans built kilowatts. Today the foreign journals referred to earlier, such as the *RSGB Bulletin, Das DL-QTC,* and *UKW Berichte*, carry an amazing array of flea-power projects surrounded by advertisements offering transistorized low-frequency and UHF stations. Our magazines, on the other hand, are saturated with linear amplifiers and 2000-watt band blasters, while our advertising seems to cater to the conventional big-station buyer. Somehow we have adopted the mistaken idea that power is everything.

The real truth of the matter, though, is that the American ham is generally in a better economic situation than his European comrades. He can afford the "best." Ham radio in this country has clearly degenerated to the point where status in many circles is determined by income. Not so?

A good example is found at six meters, a band that this writer feels more than qualified to talk about. Rather than generate interest in experimenting with narrowband FM, sideband techniques, and almost interference-free CW, the 50 MHz band is presently presided upon by the DX-happy. Who can snag the most states? When will Puerto Rico slip in again to be pounced upon by 912 East or West Coast snoopers? And they are almost all doing it with AM phone. Nobody builds here anymore. It "isn't necessary." Others feel that "commercial competition has made it cheaper to buy 6 meter rigs." Hogwash. Of course I'm not talking about the dedicated Technicians who are there for legitimate reasons; I'm calling out the 85% whose goal is to buy bigger and better equipment as they can afford it. Naturally, with a philosophy like this prevailing on a ham band, newcomers are apt to feel that unless they can afford to buy the best they just won't be "in it." And the sad truth is that they aren't.

Smashing the Price Barrier

So fervent is the struggle for power on the ham bands today that thousands do not realize just how little they are buying for the hard-earned dollar. The real difference between 75W and a full gallon is inconsequential when compared open-mindedly to the economic ratio of either building or purchasing a three-element beam to replace a folded dipole. Or when compared to spending even one-quarter that amount for a good preselector or Q-multiplier.

Communications – *true* communications – is an art. If DX is your forte, working stations others can't even hear should prove extremely exciting. Yet I'll wager you could do it by properly investing but a fraction of what you have already spent into refined necessities. Don Stoner W6TNS has WAC on 15 CW running 80 milliwatts. ZL1AAX works regularly into the states with 20 milliwatts. K1CRD in Connecticut sets his own 50 MHz records using but a 27 milliwatt transceiver he built from combining various transistor circuits in current electronics journals. Interested?

Offering an answer to the long-standing price barrier facing even American amateurs, the transition to QRP is just beginning to catch. And to the avid exponents of the sport, a challenge is there to be delved into, examined and explored to the hilt. What is there for people interested in flea-power today?

Plenty. Although the London QRP Society folded in the early fifties, in something short of four years the new QRP Amateur Radio Club (headed by K8DZR in Ohio) has snowballed into one of ham radio's largest fraternities. With members all over the world, the QRP ARC sponsors contests, proves the truths of low-power hamming every day, and publishes a handsome quarterly brimming with interesting case histories and construction projects.

Since the high power stigma has begun to alleviate, QRP'ers are striving for cheaper and cheaper rigs. QRP ARC chap-

ters offer prizes for the best units built for under $10. Now circulating are circuits for low-frequency receivers (less than $4) and AM transmitters for 20 meters (perhaps $12). And then there are all those slightly used CB transceivers that can be modified by a child for 10 meters. . .very cheaply. And I could go on and on.

The Ugly American

But by and large, high power still has a long way to go before it is completely abolished. As long as the law says Americans can run 1kW input to the final, even though most foreigners are restricted to under 100W, the DX man's toy will remain. What happens?

In all truth, the amateur's status symbol is his cherished homebrew gallon, more often than not a brilliantly conceived jumble of war surplus tubes and a power supply capable of pumping at least a thousand watts to the final. With a gleam in his eye the operator seeks out his prey (frequently a poor Belgian with 40W), zeros in for the kill and then, along with 74 others, calls him frantically. Silence follows. If I only had more power, our friend thinks to himself. But alas, he came back to an Englishman.

With the staggering number of postwar hams that put signals on the air as amateur radio developed into a modern-day mania, the high-power struggle seems to have intensified. By 1958 literally hundreds of illegal *California Kilowatts* were relieved of their licenses for power levels often up to 5kW and beyond.

What have we really accomplished in this high-power battle? Presently the supposedly sophisticated U.S. hams have literally saturated the spectrum, clobbering each other and the rest of the world as they swish their vfo's to clear the frequency before kicking in the linear. We have out-populated our allotted frequency space 25 years earlier than the best authorities estimated just a few decades ago. We have imposed American-made pandemonium on the worldwide DX bands.

German hams can't hold decent conversations with the English because some operator in Tuscaloosa is using his kilowatt to talk to New York. Frequency allocations being what they are, *more power means more QRM!*

The status-seeking "Ugly American" is heard round the world – regardless of whether or not anyone *wants* to listen. Today a good number of foreign hams have decided not to QSO the states and to ignore as best they can the innocuous U.S. kilowatts. Own up to it or not, a ham radio "cold war" is on. The cause: the power-mad DX-happy American ham.

Some Day We'll Pay the Penalty

The time is rapidly approaching when the rest of the ham world will have a substantial voice in declaring what the U.S. hams can and cannot do. Or to put in more bluntly, a growing number of previously friendly countries are fed up. They want to return amateur radio to the pioneer spirit that once led the art.

We have, admittedly unknowing, stepped on a great deal of tradition, destroying in our path to bigger and better things the very foundation of what the rest of the world still clings to in its interpretation of amateur radio. We can expect the worse, and accept (without further embarrassing ourselves by stupid on-the-air remarks) whatever Geneva comes up with.

The Horrible Truth About CB

Ask your typical coworker at the office what he thinks of when he visualizes a ham radio operator. Chances are he vaguely remembers visiting a boyhood friend who demonstrated his rig, talking gibberish to Rangoon while the coworker looked on fearfully at his homebrew monster flickering in its chassis.

Or more realistically, he remembers last Saturday night, when Lawrence Welk was all but obliterated by the youngster next door.

The point is simply that the impression is not good. Ask a friend the difference between a ham and a CB'er and he'll reply with the best of intentions that the ham uses radio as a toy, whereas the CB'er has a definite purpose in putting his set on the air. The public is not aware of the fact that we are supposed to be technically better informed than the CB'er.

The horrible truth is that we *are* competing with the CB'ers whether we want to

recognize it or not. The same legislative body that gave experimenters frequencies they could use for furthering the art awarded a mere 250 kHz of the 11 meter band to citizens. And what have they done with it?

To be perfectly frank, the accomplishments of CB fall just short of miraculous and something hams will have to reckon with sooner or later. Putting aside the reams of anit-CB material we publish (the more opinionated referring to them as morons*), we should at least admit the facts:

- There are literally thousands of CB clubs throughout the country cooperating with local officials to aid in emergencies.
- The press has treated CB most favorably, publicizing in newspapers and magazines the strength and power they have added to ambulance squads, police departments and highway patrols.
- The public is not plagued by nearly so much CB TVI as we would like to believe. Improvements in equipment design and the 5W power limitation do much to hold this down.
- In numbers, CB'ers are expected to top one million this year.
- Sales of CB equipment hit $54 million in 1966.
- CB offers more to the public (tangibly, at least) than amateur radio.
- America now has an emergency radio force of citizens exceeding that anywhere on earth at this time.
- At least 70% of CB units are installed for "emergency power" – under the dash.
- Detroit's leading automobile manufacturers appear anxious to arrange for CB as optional equipment in the near future.
- The FCC has already given the go-ahead for a mass program for an automobile emergency corps on CB channel 9, and has restricted channel 9 for emergency use only.
- CB can be effectively and profitably used in business – whereas ham radio cannot.

Like it or not, the above points are cold, hard facts. And they are darned tough to argue with.

So who cares about CB? Every amateur should be vitally interested in all that occurs on 27 MHz if he values his hobby. In the learned eyes of the electronics industry, the FCC and the general public, CB is accomplishing the very thing that amateur radio was founded to do.

A great number of us are under the dangerous misconception that amateur radio is primarily an exciting hobby, offering something that can be found no where else. The sad truth is that this is but a byproduct. To quote the FCC in an age-old phrase: *"Amateur radio exists because of the service it renders."* And exactly what service *do* we render that CB does not?

We spend a great deal of our time studying award requirements and calling directional CQs. We pride ourselves additionally in keeping abreast of advances in electronic communications. We try to outguess the experts by coming up with new ideas and effective techniques that the country can use. We are constantly building and improving in an effort to develop ourselves as communications specialists, or amateur engineers, as it were. We admit only the scientifically minded and those eager to learn more about electronics. Or do we? Are we really as technically advanced *individually* as our forebears? Can we honestly state that we have superior motives that will help America stay ahead technologically in the electronics race? *Can we?*

. . K2ZSQ/W9HBF ■

Tell our Advertisers You Saw it in 73

* *Auto-Call, February 1965 edition*

BREW 1 on 2
A TWO METER COAXIAL

It was an ordinary Saturday afternoon, as I sat in my garage hamshack drinking a cold brew. What I needed was a good 2 meter antenna. With one sterling qualification: it must be cheap, cheap, inexpensive. I rolled the brew can around in my hands and the idea struck me – why not make a coaxial antenna with the empty beer cans; I'd heard of beer can verticals – why not a beer can coaxial?

So, I broke out the ruler and found that four empty beer cans measured just over 19 in. With haste, I dug out the soldering gun, solder, and tin snips. First, I cut the tops and bottoms out with a can opener (I left the bottom in one and drilled it to accommodate an SO-239 connector). (See Fig. 1.) When this was completed, I made up a piece of coax (RG-59 or RG-9) 38 in. long with a PL-259 at each end. I connected one end to the SO-239 on the top can. This was easy at this point, but would be practically impossible later.

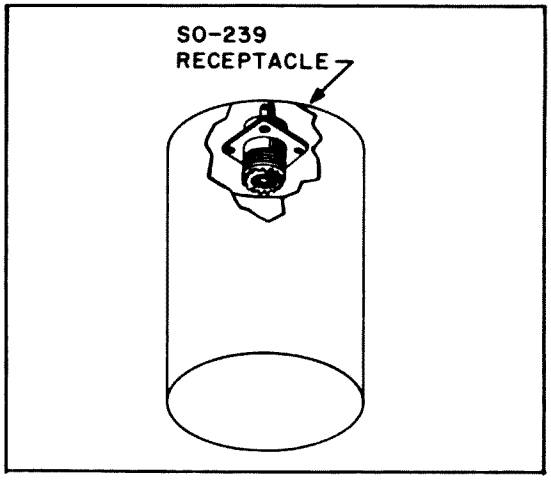
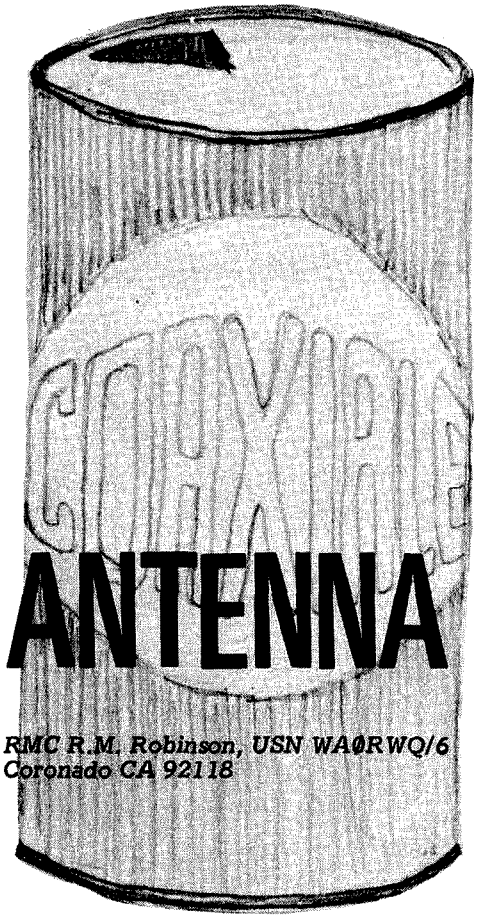


Fig. 1. Cutaway view of top can shows SO-239 inside can. The transmission line will have to be connected before the connector is attached, unless you have very, very small hands.

Then I slid that piece of coax through the center of the remaining three cans and soldered all four as shown in Fig. 2. I used a piece of 19 in. stiff wire for the radiator, and soldered it to the end of the SO-239 sticking out of the top can. If you duplicate the antenna, you'll find welding rod, coathangers, etc. quite satisfactory. Mounting is up to the builder; also, I would suggest spraying the cans with antirust



RMC R.M. Robinson, USN WAØRWQ/6
Coronado CA 92118

paint. I mounted my antenna on an old broomstick with electrical tape. Swr can be changed by shortening or lengthening the 19 in. vertical.

To trim the antenna, it is better to bend the top over a bit at a time rather than cutting it. This is so that when you pass resonance your vertical won't be too short, and you can straighten out the bent portion, rather than to have to replace it.

I used a Heathkit Twoer with about 2W output. Swr at resonance was about 1.2:1 at 145.5 MHz. I found it was quite broad, QSYing nicely without a drastic increase in swr. My antenna is about 20 ft off the ground and about 4 ft from the roof on its broomstick mast.

My first contact was with WB6YO1 in Fallbrook, Calif., about 25 miles away. I also noticed I could receive stations I never could hear before, and those I could hear were much stronger than on my old groundplane. Not bad for two hours work and no cash outlay.

I won't go into the problems associated with trying to solder aluminum. If the brew you drink comes only in aluminum cans, you'd better be good at silver-soldering; otherwise it might be wise for you to change brands for one evening.

. . . WAØRWQ ■

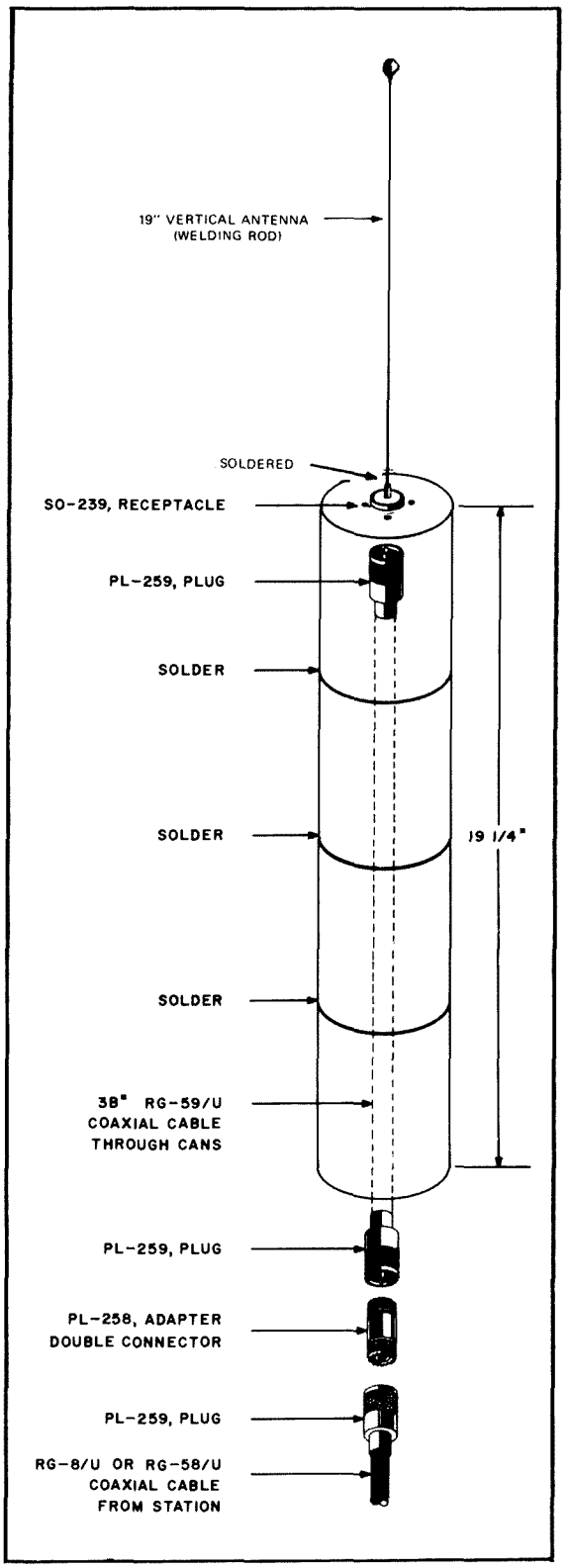


Fig. 2. Sketch shows connector required and overall construction of the beer-can coaxial.

CONVERTING 24V DC RELAYS to 115V AC

Alan Douglas
Box 225
Pocasset MA 02559

How often have you pawed through your shoebox of surplus 24V dc relays, looking for something for a 115V project, and wished you could change them over with a wave of your magic wand? Well, it's almost that simple; nearly any such relay will operate on 115V with the addition of two diodes and a resistor. And how many 48V telephone relays have you salted away, waiting to build a 48V power source to run them? They are even simpler to use; all it takes is a pair of diodes.

The classic circuit for getting 24V dc consists of a transformer, rectifier, and filter capacitor (Fig. 1). You can simplify this a little by replacing the transformer with a dropping resistor, providing you increase the capacitor's voltage rating to 150V, since without a load the voltage would rise to that value. If you have used this circuit before, you know that the capacitor is at least twice the size of the relay, and probably as expensive.

Now throw away the filter capacitor, and replace it with a diode. Filtering is provided by the inductance of the relay coil, instead of by the capacitor. To simplify basic theory, an inductor will try to keep steady the current flowing through it. If half-wave-rectified ac is applied, current flows in short bursts of 60 per second; in a relay it causes the familiar 60 Hz buzz. The diode provides a path for the current to flow between ac cycles, so that the coil current remains fairly steady, instead of being cut off abruptly 60 times a second.

This circuit works fine with most surplus relays which have a high coil inductance. The newer "crystal can" miniature relays are about the only exceptions. The 48V telephone relays are a snap to use because only a very small dropping resistor, or none at all, will operate them. Note that since the relay will tend to hold on after the power is removed, it cannot be operated as fast as a conventional relay. This is likely to cause trouble only in a keyer circuit.

No additional arc suppression is needed, since the shunt diode eliminates the transient voltages normally produced when a relay is turned off. This is, in fact, a very common arc-suppression arrangement in conventional dc circuits.

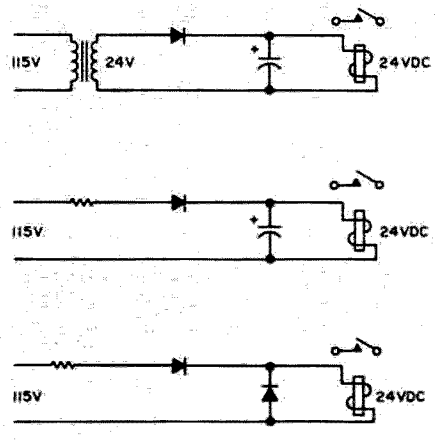


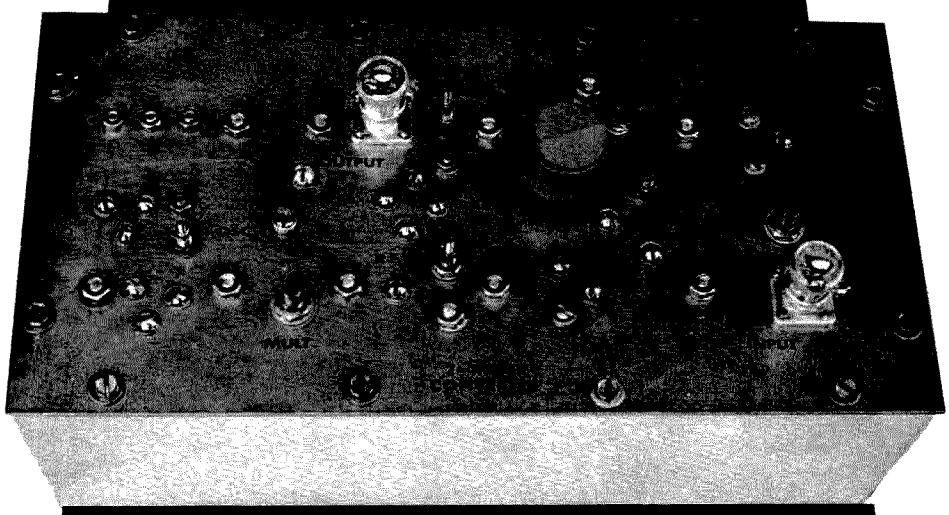
Fig. 1. In these three circuits, the result is the same. Circuit C is the simplest, though, with just one resistor and two diodes. Diode ratings should be at least one-half the relay coil current, and 200 PIV. The dropping resistor should be equal to the relay coil resistance.

Now, rush to your nearest surplus dealer and pick up a supply of relays before he reads this and ups his prices.

. . . Douglas ■

Robert D. Morrison WB6YVT
1590 De Leon Way
Livermore CA 94550

A VERSATILE and STABLE MOSFET CONVERTER for 144 MHz



Here is a converter which offers just about the optimum in tube and solid-state performance. Its characteristics include the following.

- Low noise figure.
- Excellent cross-modulation performance, dynamic range, and overload control.
- No neutralization, stagger-tuning, or reduced gain operation is required to prevent rf oscillations.
- Complete stability. The rf stages of this converter have never oscillated under any conditions of tuning or antenna source impedance. In addition, the local oscillator has high amplitude stability and has never required any readjustments.
- High gain with a very effective rf gain control.
- Wide bandwidth, which allows operation over the entire 144–148 MHz range with no repeaking of the converter required.

Circuit Description

The dual-gate MOSFET appears to be the new darling of the front-end designers.

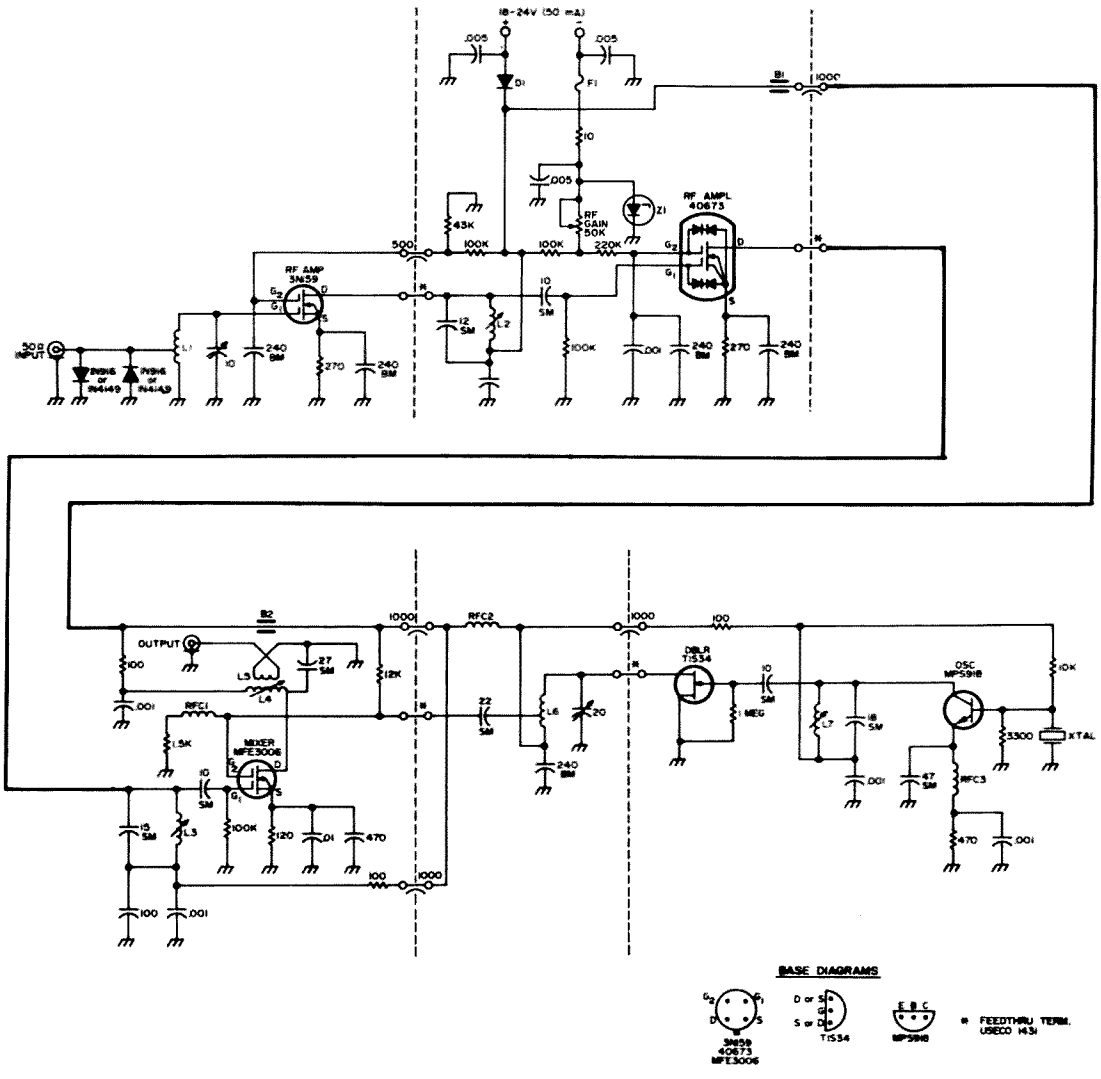


Fig. 1. Schematic diagram of the converter. Any one of the MOSFET types 3N140, 3N159, or MFE3007 may be substituted for any of the MOSFETs in the schematic. However, a 3N159 will give the lowest noise figure in the first stage. A 40673 should give the best protection against any rf spikes in the second stage. And a MFE3006/MFE3007 should give the best protection against steady, high-voltage rf signals in the mixer stage. All resistors are ½-watt carbon, 5%. All fixed capacitors other than SM, BM, or feedthrough types are disk ceramic.

It has surpassed the performance of tubes, bipolar transistors, and junction FETs with but one exception. This exception is that the junction FET gives about a 1 dB lower noise figure in the VHF range. This extra decibel of sensitivity may be useful to moonbouncers and those who live in remote areas, but if you live near populated areas, the sensitivity of the MOSFET is more than adequate to get you down into the atmosphere noise.

An important advantage of the dual-gate MOSFET is that, unlike the "triode" transistors, it does not require neutralization. Of course, if the builder uses second-rate shielding and bypassing techniques, even the dual-gate MOSFET will oscillate.

They key to the stability of the new present converter is that the rf MOSFET gate 2 source leads are soldered directly to button mica bypass capacitors. In addition, there are shields between each stage, and the rf MOSFET drain leads are soldered directly to the shield feedthroughs. Something to remember is that the series-resonant frequency of a bypass capacitor

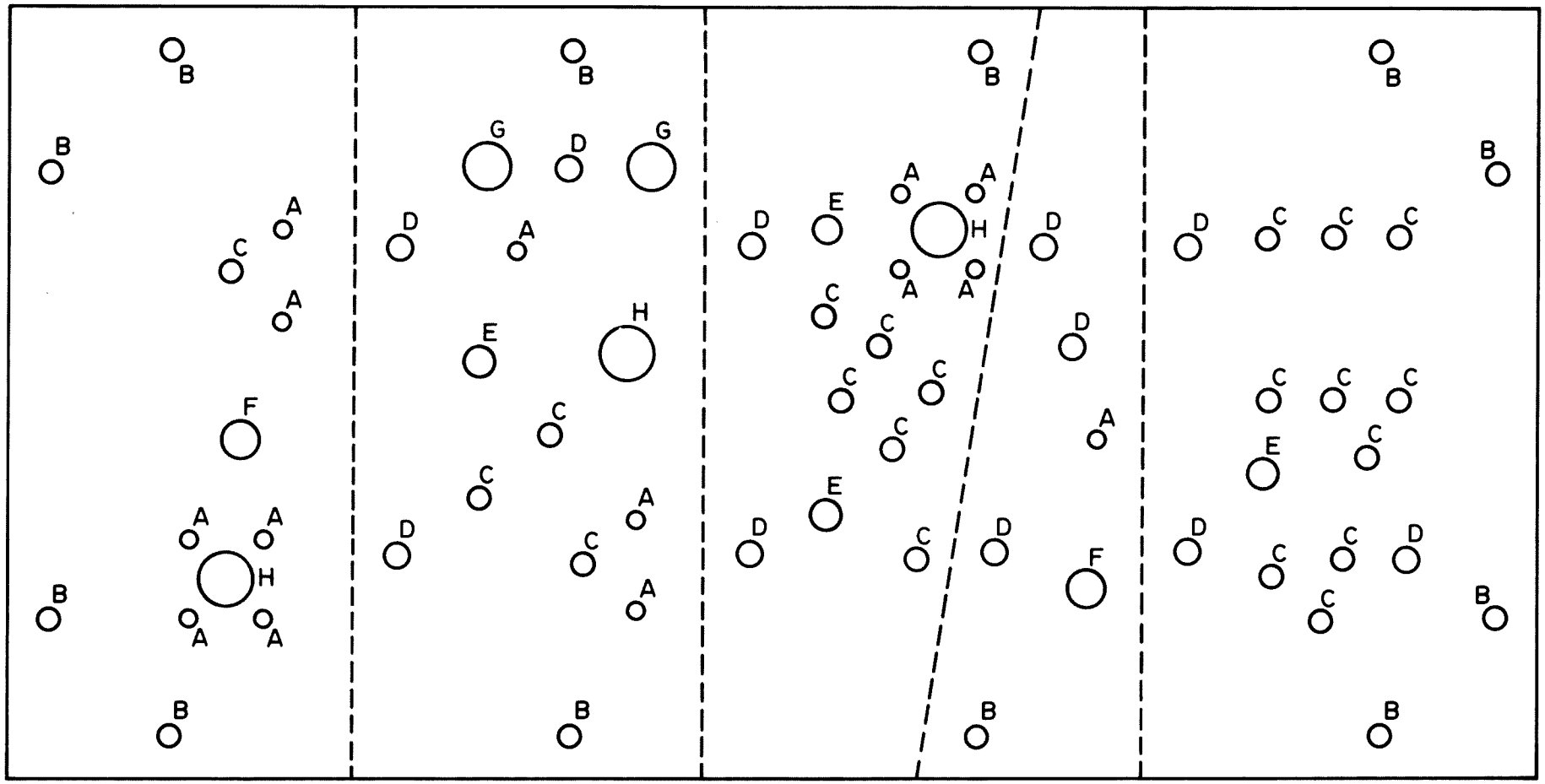


Fig. 2. Reduced-size template of chassis plate (bottom view) shows hole size and placement. The letters indicate drill sizes: A—No. 37, B—5/32 in., C—No. 26, D—No. 17, E—3/16 in., F—¼ in., G—5/16 in., H—3/8 in. The broken lines represent shielding.

should equal or exceed the frequency to be bypassed.

Figure 1 shows the converter circuit. The first rf stage uses an RCA 3N159. At the time of this writing, this transistor has the lowest 200 MHz noise figure of all dual-gate MOSFETs on the market. This stage is biased to run at "wide-open" gain for best sensitivity. The input tank has a fairly wide bandwidth so that a low noise figure is maintained over the entire 144–148 MHz band with no repeaking of the converter.

Silicon high-speed diodes are used at the antenna input. These diodes have a negligible effect on the input circuit. Germanium diodes conduct at about 0.1V so that signals above this value will be distorted. Silicon diodes, on the other hand, conduct at about 0.5V. The MOSFET, with its insulated gate, has a higher gate voltage tolerance than the J-FET whose gate will conduct at 10.5V bias. As a result, the silicon diode–MOSFET input has considerably greater overload tolerance than the germanium diode–J-FET input combination. For extreme overloads, each silicon diode may be replaced by two silicon diodes in series.

The second rf stage uses an RCA 40673. This MOSFET has integrated back-to-back diodes from each gate to the source. These diodes protect the silicon dioxide insulation from breakdown by the high-voltage spikes of static discharge. Unlike unprotected MOSFETs, these transistors require no special handling techniques.

The linear pot and 4.7V zener network provides an adjustable gain range of about 50 dB from full on to full off. The 100 kΩ resistor connected to the pot provides a gate 2 voltage of about 1V at maximum gain. This 100 kΩ may be reduced to give a higher bias and a slightly higher maximum gain but the gain control action may become more abrupt and possibly bothersome.

If the converter is to be used with a good antenna and high-gain receiver, one rf stage probably will provide adequate performance. If desired, the gain control could be applied to the first stage. To avoid parasitic oscillations, it is important to

DUAL GATE MOSFET
PRE-AMPS



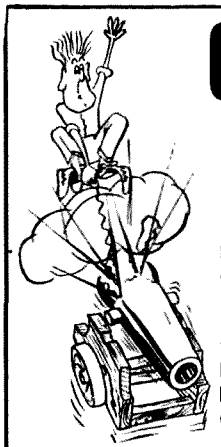
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keep the gate 3 dc bias resistors out of the first-stage compartment.

Undoubtedly, the dual-gate MOSFET is the best of the transistor mixers. With the signal input at gate 1 and the oscillator input at gate 2, the problem of oscillator feedthrough to the rf circuits is greatly reduced. Also oscillator detuning by the rf circuits is minimized. The mixer presents a high impedance to the oscillator circuits, so that the oscillator drive requirement is low. The square-law response of the MOSFET greatly reduces cross-modulation distortion. The MOSFET is also very resistant to overload, which is a highly prized characteristic for mixer operation.

A Motorola MFE 3006 silicon nitride passivated dual-gate MOSFET is used for the mixer. The gate breakdown voltage ratings of ±35V are considerably greater than the ratings of the unpassivated MOSFETs. Because very high steady rf voltages may appear across the mixer terminals, the higher breakdown voltages of this transistor are deemed more appropriate. This transistor is still quite vulnerable to voltage spikes so that handling precautions are necessary. (The Motorola MFE 3007, by the way, is an improved version of the MFE 3006.)

The present *mixer–local oscillator* injection voltage is 2.5 peak (1.8V). Higher injection voltages will produce more gain, while a somewhat lower injection voltage should produce slightly less mixing distortion. Distortion control and gain are both excellent at the present 2V peak oscillator injection level.

The 14–18 MHz mixer output coil has a fairly wide bandwidth so that no readjustment of the converter is required during operation over the entire 144–148 MHz range. For receivers with input impedances other than 50Ω, the turns ratio of the mixer output coil should be adjusted to give a suitable bandwidth.

By the time this article appears in print, some manufacturer will probably be marketing a dual-gate MOSFET which has the low noise figure of the RCA 3N159, the protective diodes of the RCA 40673, and the silicon nitride passivation of the MFE 3006. This could possibly be the ultimate in silicon channel MOSFETs. Of course, a second manufacturer may later one-up the first by marketing a gallium arsenide channel MOSFET, and then later still, a third may bring out an integrated circuit that has... There is nothing like free enterprise to keep the manufacturers sharp and the ham builders happy.

The fifth-overtone oscillator circuit is excellent. It has exceptional amplitude stability, adequate frequency stability, good output power, and low output impedance. It was suggested by Bill Carver K6OLG, who believes it may be a variation on an original design by Frank Jones W6AJF.

The TIS34 J-FET doubler has a fairly high input impedance, a high output voltage, and is very simple to construct. The 65 MHz fundamental is better than 20 dB down from the 130 harmonic in the doubler output. This ratio is not earth-shaking, but it is adequate for the application.

The oscillator–doubler combination produces a strong, stable output, and can operate over a dc range of 5–25V.

The converter is designed to be used with a 50Ω antenna and a receiver of approximately 50Ω input impedance.

Construction

A 5 x 10 in. brass sheet of 40 mils thickness serves as the chassis plate. The shields are made of 30-mil brass plate and are bolted to the chassis plate. The brass plate on my unit (pictured) has been tin-coated for appearance and contact resistance stability. The tinned brass plate is held to an inverted 5 x 10 x 3 in. aluminum chassis by sheet metal screws. Aluminum and tin are more galvanically compatible than aluminum and brass. Of course, any two dissimilar metals in contact can produce corrosion if the conditions are right. The tin–aluminum combination used here should give no problem. Figure 2 is reduced-size template showing hole positioning, shield placement, and relative hole sizes.

Transistor sockets are not used. The leads are soldered directly to button mica bypass capacitors, shield feedthroughs, or to ceramic standoffs. All ground lugs are

soldered directly to the chassis plate.

Ceramic slug-tuned coils are used throughout with two exceptions. Air-core coils, with their higher Q values, are used for the antenna input coil and the doubler output coil. (A complete parts list appears in Table I.)

The ferrite beads are novel and may be replaced by 33Ω resistors, if desired. Ferrite beads have the advantage that they have zero dc resistance – a disadvantage is that their ac resistance is significant only above about 50–100 MHz.

This converter probably should not become a first VHF project. At 2 meters, capacitors can look like inductors and inductors can look like capacitors, regardless of what is stamped on the outside of the component.

The oscillator should be built and tested first. A 2N918 or MPS 918 must be used in this circuit. When the oscillator is performing well, the doubler can be added. A TIS34 or 2N3823 should be used. A TIS88 (2N5245), MPF107 (2N5486), or 2N4416 with their higher gain may cause undesired oscillations.

When the oscillator–doubler chain is working, add the mixer. Use an RCA 40673 protected MOSFET for experimentation at this point since the other MOSFETs are too easily damaged by constant insertion and easily interchanged.

Any problems in the oscillator–doubler–mixer chain should be solved before installing the two rf stages. The second rf stage should be added and made stable. Then the first rf stage can be put in. All dc bias resistors of the first rf stage except the source resistor should be kept out of the first rf stage compartment.

After the converter is completely stable, the top on the antenna input coil should be adjusted for minimum noise figure. This should be done with a noise generator, but a weak 2 meter signal should also suffice.

The builder may find that the capacitor values needed in the tank circuits differ from those given on the schematic. This is to be expected, since slight geometrical changed can affect the frequency response of tuned circuits at 2 meter frequencies.

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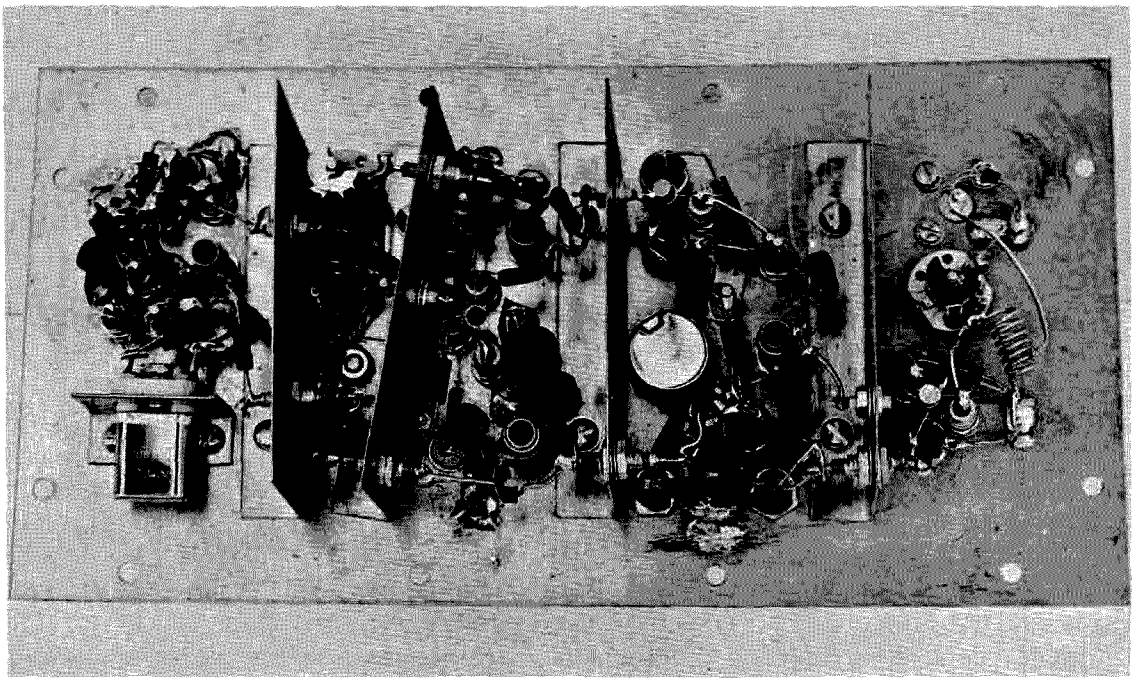
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Construction details and component placement are clearly shown in this head-on view of the segmented converter.

damaged by improper handling procedures. Adequate procedures to prevent damage are as follows.

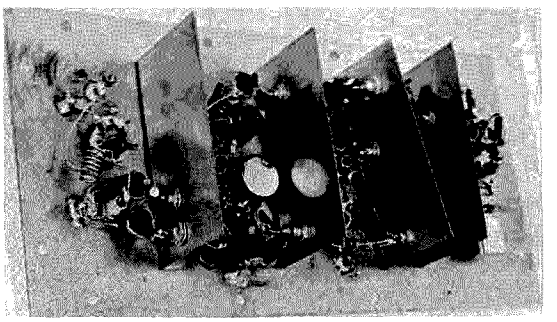
1. The soldering iron tip should be grounded to the converter chassis.
2. The lead to be soldered (or the lead that is connected to the point to be soldered) should be grounded to the chassis with a clip lead.
3. The metal ring supplied with the transistor can be replaced with a ring of solder if the solder firmly contacts all four leads.

Once the MOSFETs are in place and the converter is working properly, there should be no more concern about damaging the MOSFETs.

Performance

The following results were obtained with the antenna coil tuned to 146.0 MHz, the second rf coil tuned to 144.5 MHz, the third rf coil tuned to 147.5 MHz, and the mixer output coil tuned to 16.0 MHz. Other combinations may work better with a different antenna and receiver.

1. The measured noise figure is about 3 dB.
2. The measured gain is about 50 dB.
3. The measured gain control is about 40 dB for a 0.1V rms signal, and about 60 dB for a 10 mV signal.
4. The bandwidth is wide enough that a 3 dB noise figure and a fairly constant gain persist over the entire 144–148 MHz range with no readjustments on the converter.
5. A 0.1V rms antenna signal produced no significant distortion in the converter; however, a strong signal may produce distortion in the receiver mixer, since the converter can put several volts of rf into the receiver mixer. In this case the converter gain control or the receiver rf gain control should be used to attenuate the



The shielded compartments are (left to right) first rf stage, second rf stage, mixer, doubler, and oscillator. The crystal can be seen against the chassis plate in the oscillator compartment.

strong signal. At no time during initial operation of my unit did the converter gain control require any decrease from the maximum. The receiver gain control did require downward adjustment on very strong signals, however. Incidentally, it was observed during this test that the converter front-end noise was negligible compared to the atmospheric noise. The test location was in the Livermore valley 30 miles east of San Francisco.

6. The converter is completely stable. The local oscillator has never required any adjustment. The two rf stages have never oscillated, but they have remained stable and broadband under all conditions of operation.

Table I. MOSFET 2m Converter Parts List and Symbol Explanations

SM — Dipped silver mica.
BM — Button mica (Erie).
L1 — 7t 18-gage tinned wire, air-wound ½ in. long on 7/32 in. inside dia. Tapped approx 1 5/8 turns from cold end.
L2, L3 — 2¼t 18-gage enam. wire, closewound on ¼ in. dia slug-tuned ceramic form (Miller 4500-4, white core).
L4 — Slug-tuned, 3.1—4.8 μH (Miller 4504).
L5 — 4t 220gage insulated wire wound around L4.
L6 — 6t 18-gage enam. wire, air-wound ½ in. long on 7/32 in. inside dia. Tapped approx. 1½t from cold end.
L7 — 4¼t 24-gage enam. wire, closewound on ¼ in. dia. slug-tuned ceramic form (Miller 4500-2, red core).
RFC1, RFC2 — 2.2 μH molded rf choke (Miller 9320-14).
RFC3 — 1.5 μH molded rf choke (Miller 9310-16).
Z1 — 4.7V zener, 1W (Motorola 1N4732).
D1 — Silicon diode, 100V PIV min, 300 mA min.
F1 — Standard fuse, 1/8A.
XTAL — 65.000 MHz, fifth-overtone, series-resonant crystal.
B1, B2 — Ferrite beaded (Ferroxcube, Stackpole), or 33Ω resistor.
Air capacitors are Hammarlund MAC-10 and MAC-20.
2 BNC receptacles, 2 banana jacks, 15 ceramic standoff insulators.

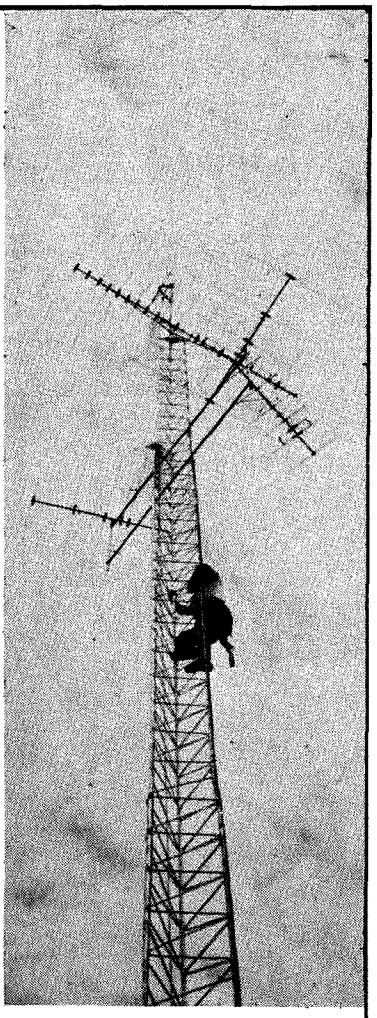
The experienced VHF builder will find this converter to be a satisfying construction experience. The 2 meter operator will be quite happy with its stable, all-around performance.

. . . WB6YVT ■

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LETTERS

2-Channel Search-Lock

Several questions and comments have arisen concerning the 2-channel search-lock article (July 1970).

In Fig. 1, the capacitor connected from the emitter of the unijunction transistor (Q1) should be 0.47 μF. Transistors Q2, Q3, Q8 and Q9 can be 2N3641, 2N706, GE-17, Motorola HEP 50, or any similar type.

The waveforms of Fig. 6 should be labeled as follows:

Top left: emitter of unijunction transistor Q1.
Top right: base 1 of Q1.
Bottom left: collector of either Q2 or Q3.
Bottom right: base of either Q2 or Q3.

The pin numbers listed for IC-1 in Fig. 1 are for the standard 8-pin TO-5 package. If a dual-inline or a flatpack is used, the pin numbers will have to be changed accordingly.

In the picture of Fig. 2, the two lamps mounted adjacent to the upper main power toggle switch are the active channel indicators. I used Dialco subminiature series 252-9951-XXX lamps which are quite small.

I have been asked how this circuit can be modified to provide for more channels. This can be done by replacing the flip-flop (Q2 and Q3) with an appropriate ring counter circuit. I hope to develop such a circuit and present it in an article in the near future. A kit of all the semiconductors required for the 2-channel project is available ($8.88) from Poly-Paks, Box 942, South Lynnfield, Mass. Specify article title, 73, July 1970.

R. Gary Hendrickson W3DTN
1510 Jupp Road
Glen Burnie MD

Computer Comparison

The other month I wrote a series of complex "macros" (I teach computer programming) to serve as a class example. The outgrowth was that I created a little system that could be used to extract data from a data base by a logical combination of keywords. For example, "Extract the record if the keywords *antenna* and *vertical* are present." The next step was to (and what a step) convert the tables of contents of the major ham magazines into punched card form to serve as the data base. My idea was to be able to take all of the technical articles appearing in 73, CQ, and QST for the past 5 or 10 years and get them collected so that surveys could be easily generated. Something interesting happened. . .1 kid you not. . .the ratio of technical articles became most apparent! 73 was way out in front. Then I decided to do the same thing (or try to do it) for articles of interest to FM nuts like myself. Again, but even more dramatically, 73 was out in front.

Thomas R. Yocom WA0ZHT
1530 Country Club Dr
Marion IA



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Autopatches

I can assure you that the "Autopatch" you have described in 73 Magazine is illegal. I know. I just spent three days per month for the last seven months in Washington as a member of the Academy of Sciences panel engaged in a study of the effects of interconnection to the telephone lines. The present tariffs *permit* interconnection of voice or data information through a coupler which acts to isolate foreign voltages, capacitance unbalances, grounds, etc., from the lines.

The tariffs *prohibit* any signaling or control functions from being done by the customer which includes dialing, on hook-off hook controls, and ringing. There are indeed many more considerations than meet the eye in this latter category. Dialing at 10 pulses per second isn't all that is required. The percentage make/break is a more stringent requirement at 61% nominal with 58-64 min/max limits. Maintaining capacitive balance on the lines is essential, otherwise crosstalk will ensue. The possibility of foreign voltages being placed on the lines is another serious concern.

No, I don't work for the telephone company. I am just a member of the electronics industry that was called upon to objectively evaluate the interconnection issue. The panel's recommendation has just been presented to the FCC and I understand the report is available from the Academy of Sciences for $4.50.

Being a ham, I am emotionally torn towards allowing free interconnection but also being a technical consultant, I can see the dangers in allowing free and uninhibited interconnection. Our panel recommendation is to open up the present "telephone company only" approach by allowing *certified* manufacturers and personnel to interconnect. So, there is hope for the future.

Herman Lukoff W3HTF
506 Dreshertown Road
Fort Washington PA

As we interpret the tariff, signaling with foreign equipment through a phone line is indeed illegal, unless a specific phone company authorization is obtained. But dial-type autopatches do not involve phone line transmissions of externally generated tones, even though touchtone patches, of course, do.

Your wrap-up of the make-break-ratio importance is quite correct, but most amateur repeater builders are aware of this. Most use ordinary phone dials for pulsing and adjust the dials as

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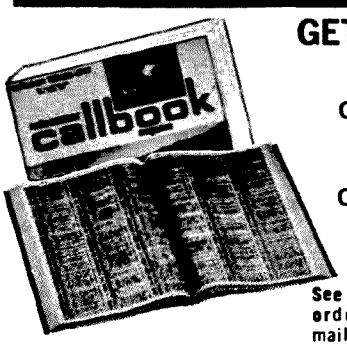
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necessary to comply with requirements. Amateurs are also sensitive to maintaining good isolation between their circuits and those of the phone.

Nonetheless, strictly speaking, the phone companies do require a terminal unit (officially installed) between foreign attachments and the phone, although no ham repeater has ever been known to be reprimanded for illegal interconnection.

The whole tie-in business will eventually be dealt with in specific terms for amateurs, but right now the tariffs appear to be aimed for the manufacturer of interconnect devices and the mass-scale user.

... Ken

Free Speech

It is such articles as K2AGZ's "Free Speech for Hams" which is assisting our enemies to multilate and destroy our American heritage of freedom.

His attack on Vice President Agnew is a good example.

Recently Pope Paul VI said "Too many papers use the press to defame instead of to inform."

This is exactly what K2AGZ has done in his article. Either he has never read or listened to the Vice President's speeches, or he has made up this defamation of VP Spiro Agnew from enemy infiltrations in the press.

President Jefferson once said that if our country was ever destroyed, it will be by infiltration by enemies who will use our freedoms to destroy us.

The checks and balances and criticisms which Vice President Spiro Agnew speaks of, are simply and purely self-defense of democracy and freedom.

Myron R. Fox
45 McKinley St.
Brookville OH

Pleased and surprised by K2AGZ's views in "Free Speech." Hope for more of the same!

Ken Cole
Box 3
Vashon VA

I have subscribed to 73 for a number of years and think the magazine is great for the radio information it contains. However, there are many times recently that I think its EDITORIALS *stink*. It appears to me that you – the editor – can't make up *your mind*: You express a belief that *violators* of the *regulations should* be punished, but not if their breaking the rules helps them maintain their *freedom*.

You say you are for law and order. Perhaps you are, but you sure show a leaning towards those who want to "burn it down" because it is *their right under* the First Amendment.

I still believe that 73 is a good amateur publication. But its editorials *stink!* Maybe a new editor *would improve them.*

W T McAninch
2137 Grayson Place
Falls Church VA

I would like to say that if 73 Magazine is pressing for free speech on the air – the use of obscene, indecent, and profane language – and

that whether it is that type of language to be determined by the one using it – 73 should start closing its doors!

Wayne E. Herron WQMI
1301 Church St
Scott City KS

You must be a new reader to 73 and thus not understand that 73 has no opinions, that opinions expressed in the magazine are signed and are the opinions of the writers only. Some we agree with, many we don't, but it is dishonest to censor out ideas because we don't happen to agree with them.

We reported that the FCC chairmen are having trouble with words and the interpretation of what is obscene, etc., in light of supreme court decisions. On a strictly pragmatic level one might ask what harm a four-letter word is going to do on the air . . . we are seeing it regularly now in books and magazines, and hearing it in the movies. Many people are beginning to believe that there is a possibility that some of our population is becoming adult enough not to be stricken by mere words. It takes more maturity than is generally available to be able to dismiss "dirty" words. Of course, once the emotional impact is gone, they will fade from such prominent use. (We may not notice it, since they won't bother us any more!)

. . . Wayne

FM

Just wanted to tell you that I have been enjoying your recent FM articles and the thicker magazine. I hope you run a reprint of "Chronicles of an Amateur FM Channel." I sure would like to have a copy of that in my library.

Skip Hansen WB6YMH
3614 Homeway Dr.
Los Angeles CA

"Chronicles" appears in the FM Anthologies, Vols. I and II, in its entirety.

. . . Ken

Appreciated the report on the Orlando Hamfest and FM Convention. Also, the mobile phone and search-lock FM articles were FB. Keep up the good work for at least three years (the length of the enclosed renewal).

Charles Durst WA4WTX

On May 26th I sent you a check for $15.00 for a three year subscription to 73 and the "FM Anthology." So far I have received the magazines but not the book. Being new to 2 meter repeater operation I need all the information I can get.

Thanks very much for all the FM articles being printed in 73 and for the special issue. I've been almost completely inactive for years and 73 has done more than anything else to revive my interest and get me back on the air.

Ray F. Caldwell W4VFC
525 Hall's Lane
Madison TN

Sorry about the FM Anthology hang-up. We're having printer problems, and the orders exceeded the initially printed quantity. Another week or two at the latest.

. . . Ken

Ham "Hobby" License

I find this newly proposed class of radio amateur license an interesting topic for discus-

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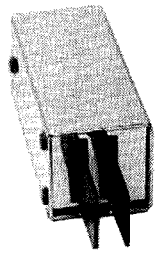
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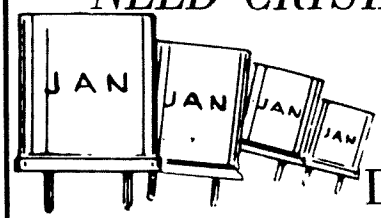
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sion. The hobby license would be beneficial for cleaning up the overcrowded conditions and irresponsible operating practices found on 27 MHz. It would also serve to increase amateur activity on VHF. This class of amateur license could be beneficial for amateur radio, providing these newcomers *were responsible* to the spectrum they would be using. This responsibility develops into a need for the knowledge of basic radio theory because this knowledge provides for the appreciation of radio. The theory these radio users need to know is the propagation characteristics of the band they would be occupying plus the general principles of what frequency modulation is (since this is the type of modulation they would be using). They should also know why FM is advantageous over other ways of supplying information to a signal carrier. The basic radio theory I have mentioned here as well as the rules and regulations already proposed, is essential to upholding the quality of amateur radio.

Paul Leary, Jr. WA4WUN
3302 Natchez Lane
Louisville KY

How about a minimum-code requirement, too; say 5 wpm?

You have just sprouted an excellent idea to eliminate the citizen band dilemma, now how about putting your genius to work on this one.

Stanely W. Pugh O. D.
2521 North Proctor
Tacoma WA

I tend to favor the "Hobby" license as described in 73, with reservations on: (1) getting a foot in the door, and (2) code should be retained for all classes except "Hobby." The code is the only prestige we hams have and we *must* retain it.

Mal WA2CDE
Box 321
Hyde Park NY

Yep, I'm all in favor of "Hobby" on 220. We hardly use the band, even in the major population areas–but think of what would happen when and if you could buy a five-channel solid state 1 watter for $69.95!!!! If they can be made and sold for this price for 11 meters, it is not that big a step to 220 MHz, as far as design and manufacture is concerned. Smart people, these Japanese! We are just around the corner from the $100 VHF FM rig, and after that is the $50 walkie-talkie!

Fritz Hervey WB4MSJ
Box 336
Indian Trail NC

. . . So now we call everyone a ham. Why not call CB'ers hams . . . what's the difference? Take 220, but give us more room on 14 or 21 MHz. Don't take only! And keep commercial interests away from ham radio – that's how we lost 27 MHz.

W8AWN

We lost 27 MHz the same way we stand liable to lose any sparsely populated spectrum. Some bright fellow said, ". . . Well, we can place the band for this requirement down on 27 MHz. This frequency is allocated to amateurs, but it's not used much."

. . . Ken

Crooked QSLing

VK4SS's article on QSLing really put it in black & white (73, July 1970). I get so disgusted with DXing that I hardly ever do it, preferring a nice domestic contact to working any DX. Reasons:

1. Pileups. I am too impatient waiting for a 20-second contact, fighting it with people who in all probability are using somewhat in excess of legal power.

2. Discourtesy. With all the break-break-break business it sounds like a bunch of CB'ers. One man in Fiji who used to live here can hardly hear his scheduled contact with the QRM aimed his way.

3. QSLing. The article says quite a bit. Personally, I like receiving and sending cards, and would gladly do it on every contact. Anybody who sends or asks for a card gets it from me.

So many of these people say, *"QSL 100%* by bureau" or some such trivia; or "Will QSL direct for IRC." So what happens? Maybe 50% come through. I went through a bunch of logbooks and made a list of stations who have not QSLed after a reasonable time (3–4 months). Maybe if a bunch of us made lists some of us could refer to the list before wasting a stamp.

One of my friends in Modesto is making up a "lid" list with a similar intention. He is going to award a "lid of the year" award with call letters engraved in a used toilet seat to the worst operator in the area. Already two or three are in mind – these guys who bumble in on a QSO with a linear, hollering "Can you read me?" while the guy they want to contact is transmitting.

Paul Schuett WA6CPP
14472 Davis Road
Lodi CA

Just finished reading VK4SS's written word about QSL "con games," and must express my approval. I'm probably not the best myself in the category of QSL WN QSLed – I just don't QSL unless requested and I don't work that much DX any more. I have been DX in the past and I can remember what it cost me after one weekend in '65 for a United Kingdom Scout Jamboree on the air and I looked over the log: 126 sent, 4 rcvd from KJ6!!

'Nuff said!

K2DAK/WA6DEK

Wha' Happen?

I received my July 1970 issue of 73 incomplete; pages 33 through 48 are missing. I enjoy your magazine very much (even with 16 pages missing).

Please don't fall into the rut the other magazines have and print a bunch of meaningless junk about contests and the like.

I would appreciate another July issue or at least those 16 mysterious pages.

W T Glenn
Rt. 1
Levelland TX

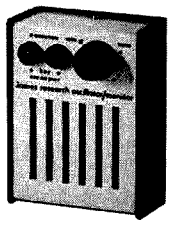
The 16 pages contained meaningless junk about contests and the like.

. . . Ken

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It seems that there ought to be some brain-busting on this, by those who claim to have brains. Some of us have been successfully driven off some bands, by the preponderance of nets.

As a kind of last resort, I am down on 21 MHz now and most of my friends are there also. However, the Peruvian Disaster Net, on 21.423, asked for and got 5 kHz on either side of that frequency. Two other nets asked for the same, also working Peru stations. All this was in the General segment of the 21 MHz phone band.

Someone suggested that all work be shifted to the section from 21.200 to 21,350, but it was vetoed. I took a look down there and found about six stations working.

Nearly everyone honored the request by the Peruvian net, as handled by W2AIM, who did a great job hour after hour.

I do not think any authority would hinder such emergency work if it was done in the blank sections of the various bands. And believe me, there are some terribly blank sections.

Now please don't give me that incentive jazz; I am far to old and feeble to compete with the young smart guys running around loose these days. So let's hear from some of the brain power up there in New Hampshire, about this NET business, and how best to handle it from now on.

Martin M. Hellman K2TAJ
61 Scott Ave.
Staten Island NY

The other evening I ventured up into the General part of 20 meters and, as usual, tuned for a blank spot (well, relatively blank) and asked if anyone was using the frequency. Yes, indeed, please QSY off the Missionary net, OM. Okay, glad to oblige, but when does the net close? In a half-hour, but then the Doctor's net will be using the frequency. I tried another channel . . . no, please QSY, this is the Maritime Mobile net. Another . . . please QSY, this is the YL net. Another . . . please QSY, this is the International Sideband net. This is the County Hunter's net. This is the Intercontinental Phone net. This is MARS, you're out of band. . .

Obviously, quite a problem has developed now that all of the nets that were scattered through the phone band a couple years ago are now jammed into the 75 kHz left for the Generals. I think this tells us why more and more phone patches are blooming in the hitherto DX part of the band around 14.200—.250.

During the prime evening hours there seems to be some sort of organized net just about every 10 kHz (it only takes seven nets to fill the band). Now, while I think that the whole idea of nets is excellent, I can see that somehow something has to give. Nets, with 10—50 stations all on one frequency, are obviously a very efficient way of providing activity for a maximum number of stations in any given band. And the pursuit of a special interest by a group obviously makes amateur radio more fun for those involved, another plus. Some of the nets provide fine public service (such as the Eyebank net) and emergency help (WCARS, etc.) But it is getting like the old prewar 80M band where there is room for nothing but nets (Postoffice net, Airport net, Broadcast Engineer's net, etc.) and there would seem to be a rapidly growing need for someone to provide a net registry service

which would stagger the nets by time and channel for the maximum use of the few General frequencies still left.

. . . Wayne

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The little PC boards made by International are more fun than anything but girls: they go together fast, work right the first time, and they are cheap. I think they are one answer to the problem of getting kids to tinker. Some of them may be overwhelmed by the complexity of today's gear and are scared off. These little boards are the easy way to learn fundamentals and we need an article about them.

F. C. Hervey
Rt. 1 Box 336
Indian Trail NC

Not Guilty!

I have delayed sending in my renewal so that I might add a comment as to my opinion of the makeup of your little book. Personally, I find it tops in its line – in particular, the brief but complete and detailed articles on the projects that a person can still find time to knock together. I had been a captive to the "Hartford Clique" for 15 years and finally woke up. As a consequence, I did not subscribe to any ham magazines until I saw a counter copy with an interesting article 73. So after a period of 10 years as a nonbeliever I am reading again. I have 35 years in advanced electronics with broadcasting, commercial, and industrial and the last few years in space electronics. Therefore, I resent my hobby being turned into something that only high-level electronic plants can produce. The big plants manufacturing ham equipment must love Hartford for the part they played in pushing SSB. (Yes, I am an appliance operator on the lower bands.) Let's *build* on two meters and up and try to keep it a hobby.

John B. Kihm
17203 Haas Ave.
Torrance CA

If your reference to "Hartford" implies that the League is responsible for encouraging sideband initially, I think your wrath is misdirected. The ARRL was one of the last to advocate SSB.

. . . Ken

Something for Everyone

I have had an amateur ticket for almost 9 years now, and I have seen all kinds of Amateur Radio magazines.

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Every amateur can find something of interest in 73 and that is what the amateur radio magazine business is all about, something for ALL amateurs.

I operate 40, 20, and 15 meter CW exclusively. You may say CW is oldfashioned, but if you become proficient at it, it is just as enjoyable as AM, SSB, FM, or any other mode. That is what I like about amateur radio; everyone has an opinion as to what he enjoys. As for the code test of 20 wpm for the extra, it ain't all that hard to learn if you apply yourself.

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Enjoy your study guide very much and I know many others do, too. Thanks for a fun magazine, keep up the good work.

Bill Weaver WA6UPC
6642 Varna Ave.
Van Nuys CA

DX'er's Complaint

Greetings from Monte Limbara, Sardenia, 4500 ft above sea level on the northwest coast of the island, overlooking the beautiful Mediterranean, home of IS1DFO.

Just finished reading about JY1 and agree completely about just how discourteous some hams are in this world. I can understand just how King Hussein feels trying to have a QSO with someone about various subject without some clown getting in there and hollering. . "Break-A, break-A, break-A," and for the most part never identifying properly, going over it several times – not only to irritate you but to let you know without a doubt that they are on your frequency with their harmonic-rich distorted modulation and to impress you with the fact that they aren't gonna shut their mouths or turn off that international homebrew jammer until you acknowledge them. I enjoy being able to talk to guys and gals all over the world and really feel privileged to share part of the limelight in being able to pass on signal reports good and bad to those desiring contact with this island . . . but there should prevail certain tact on radio, and the few who do ignore the basic rules of being polite and waiting just cause hard feelings. We make the most of it and am sure that the many we have worked enjoyed working us because we make it a point to say a few words to make it more meaningful than just a normal signal reports.

Joe (John) Johnston W5AOE
Jacksonville AR

(W2NSD cont. from page 10)

the past reporting I had read on the subject from our newspapers.

After returning home I paid a lot more attention to the Mideast, reading every news item or article that I could find, plus watching all special television reports. One of the most fascinating television programs on the subject was on NET, called "The Advocates." They argued the Arab side of the problem one week and the Israel side the next. They mentioned that the Quakers had produced a booklet on the subject called "Search for Peace in the Middle East." I sent for one.

The Quaker book is exhaustively nonpartisan and, for a small book, does a beautiful job of putting everything into perspective. They cover the Arab arguments and problems as well as the Israeli.

If you are at all interested in an objective history of the situation, complete with an espousal of both sides' problems and complaints, you should read this booklet. It certainly is an eye-opener. To make this easy for you I have arranged for our book department to have some of these on hand. Send $1 (75¢ plus handling charges, etc.) for the Quaker book to Radio Bookshop, Peterborough, N.H. 03458. Why not know the whole story? . . . W2NSD/1 ■

(Leaky Lines cont. from page 14)

any mailings they might care to send me. They have informed me that they are placing me on their mailing list, and will take the matter under advisement.

I am hoping that these inquiries will bear fruit, and will keep you abreast of the matter via Leaky Lines. Lest anyone get the idea tha nothing will come of it, I might remind him that in at least two similar instances, offending signals were dealt with through the determined efforts of amateur operators. One, a high powered teleprinter operated by NSS at Annapolis, was cleared up through the talents of W4UMC, principally. The other, a terribly troublesome Teletype in Bogota, Colombia, some years ago, was halted through the use of the telephone. A very cordial call to the office of the head of the Colombian mission to the UN resulted in the prompt cessation of the interference. Sometimes simple solutions are the best. In any case, all we can do is to try.

* * *

Now that the amateurs of practically every country in North and South America have pitched in unstintingly to render assistance to beleaguered Peru in its hour of travail, it will be interesting to observe the future attitude of that nation toward the United States. U.S. hams have been most dedicated; some of them have even stayed away from their jobs and have lost sleep, continuing to man their stations, so that the lines of communication could be kept open. I'll not go into details concerning the actual operation, since there are certain to be many articles on that subject. Let us simply state that if it had not been for all these dedicated hams, plus the presence of the U.S.S. Guam, practically converted into a hospital ship, many lives would have been lost that were saved.

In the recent past, of course, the property of some of our compatriots had been seized by Peru. Fishing vessels were interned . . . oil company installations had been expropriated. It seemed that our stock in Peru had fallen mighty low. It is a source of great pride to me, and I am sure to all Americans, that such cavalier treatment at the hands of this small country did not deter us from our willingness to offer all our resources in order to ameliorate the terrible tragedy which struck without warning.

. . . K2AGZ ■

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CANAL ZONE	21	14	14	14	14	7	7	14A	21	21	21A	21A
ENGLAND	7B	7	7	7	7	7B	7B	7B	14	14	14	14
HAWAII	21A	21A	21	14	14	14	7	7	14	21	21	21
INDIA	14	14	14	7B	7B	7B	7B	7B	14	14	14	14B
JAPAN	14	14A	14	14	7	7	7	7	7	7	14	14
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21A
PHILIPPINES	14	21	14	7B	7B	7B	7	7	14	14	14	14
PUERTO RICO	21	14	14	7	7	7	7	14	14	21	21	21A
SOUTH AFRICA	14	14	7	7	7B	7B	7B	14	21	21	21	21
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14	14	14	7B
EAST COAST	21	14	7A	7	7	7	7A	14	21	21	21	21

A = Next higher frequency may be useful also.
B = Difficult circuit this period.

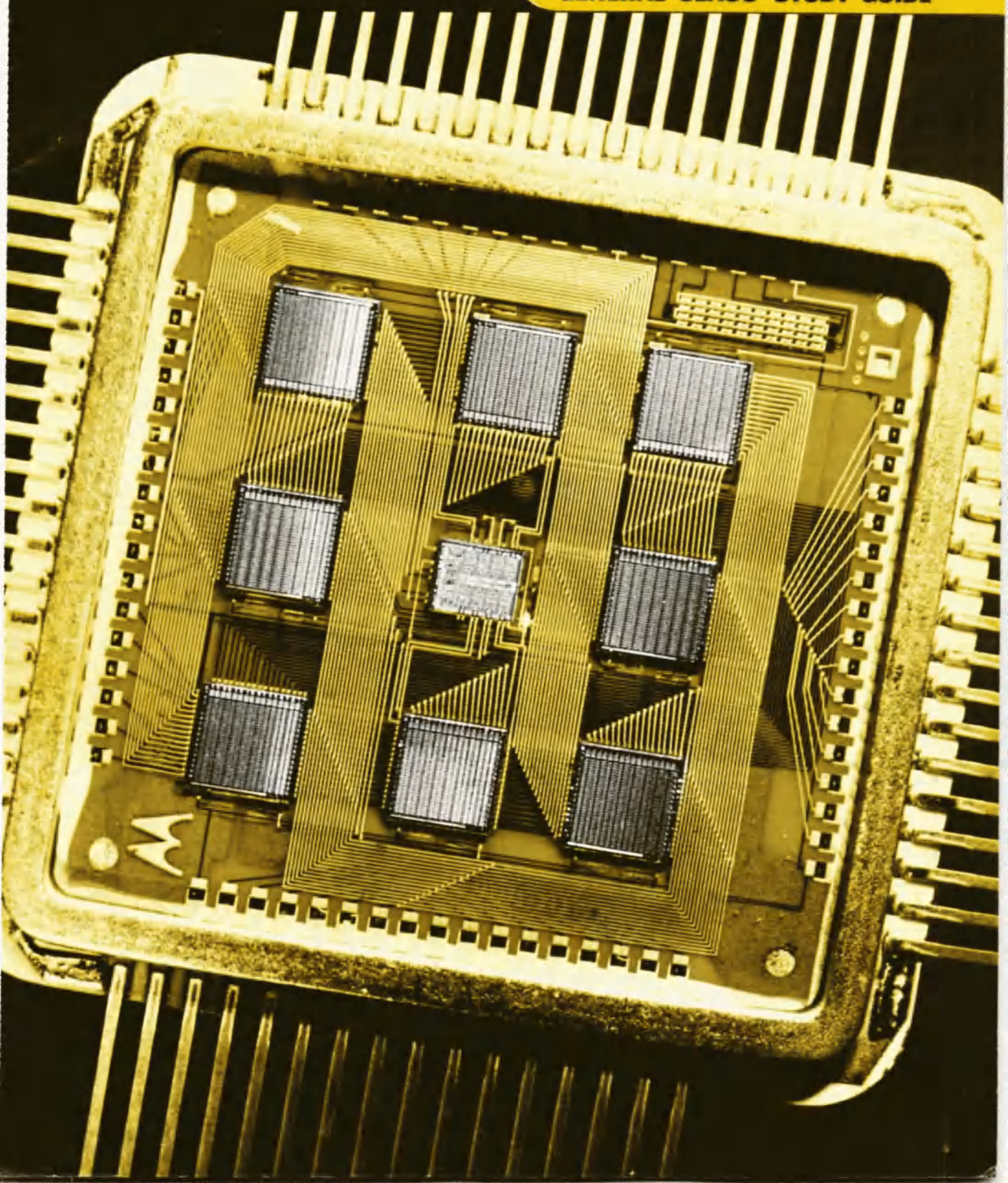
amateur 73 radio

IC Projects A Bunch!

Function Generator – Transmitters – Receivers – Regulated Power Supply – Band Edge Marker – Phase Locked Loops – How to Use IC's – etc.

GENERAL CLASS STUDY GUIDE

#120
One Dollar
October
1970



amateur 73 radio

#121 October, 1970

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We do not claim that subscribing to 73 will make you wealthy, yet we cannot overlook the many reports we have received from our subscribers telling us that soon after subscribing to 73 they found buried treasure, fell heir to a fortune, or discovered a pearl in their oyster. It is difficult to overlook the strange coincidence that the magnitude of their windfall seems to always be in direct proportion to the length of the subscription taken to 73. Is a subscription to 73 really a money magnet? Can you afford not to make sure about this?

Amateur Radio News Page

HAM DOCTORS QSO WITH EARTHQUAKE AREAS IN PERU

Communicating with doctors in the earthquake disaster areas in South America to provide medical aid and with its international ham doctor members were some of the additional activities carried on by the Medical Amateur Radio Council (MARCO) members attending the recent American Medical Association Convention in Chicago. Over 10,000 doctors were in attendance.

MARCO members talked via Hallicrafters amateur radio equipment to fellow doctors in the earthquake disaster area near Lima, Peru and also handled vital medical messages between doctors from all parts of the world attending the AMA convention and their home offices.

The Hallicrafters Company, Rolling Meadows, Illinois, a subsidiary of Northrop Corporation donated the use of the radio equipment to MARCO for its convention. It was the only radio equipment used by the members.

The major purpose of MARCO is to establish personal communications among its members and their ham colleagues for dissemination of factual medical, electronics, and communication information, both theoretical and practical. It was formed in 1966 as a charitable and scientific membership corporation designed to meet the medical–electronics and radio communication needs of its members. It now has over 400 members.

MARCO, headquartered in Manchester, Conn., has identified itself with doctors in the United States, Canada, and other countries in the world where there are doctor hams. The doctor members get to know their colleagues and develop professional, avocational, and social associations.



While attending the recent American Medical Association convention in Chicago, ham doctors communicated with fellow doctors in the earthquake disaster area near Lima, Peru. Each member of the Medical Amateur Radio Council (MARCO) used amateur radio equipment donated for the vital occasion by Hallicrafters. Standing and listening to the voices of doctors from Lima and other parts of the world was Bud Drobish (W9QVA), Assistant Sales Manager of Hallicrafters. MARCO held its fourth annual meeting and conference during the AMA convention. From left to right: Dr. Earle E. Weston (W8BXO), Birmingham, Mich.; Bud Drobish; Dr. Maurice N. Richter (K7UWP), Phoenix,

FCC PETITIONS IN PROCESS

The following is a comprehensive tabulation of amateur petitions now awaiting action by the FCC. Thanks to Bob Chapman (W1QV), ARRL New England Division director.

RM #	DATE FILED	SUBSTANCE
968	3/66	Use of other than 220 MHz to remotely control RACES stations.

1116	3/67	RACES rules, control of nonamateur licensees.
1306	5/68	Expand 10, 15, and 20 meter phone.
1346	8/68	Senior Citizens license.
1349	9/68	Expand phone privileges for KP4 licensees.
1363	10/68	"Advanced" Technician License.
1392	12/68	Permit RTTY speeds of 60, 75, and 100 words per minute.
1429	3/69	Permit F-4 at 144 MHz.
1454	5/69	Allow Techs to use CW, 80 through 10 meters.
1455	5/69	Counterpart call signs.
1456	5/69	Permit Techs to have same CW privileges as Novices.
1477	9/68	Expand phone bands for DX QSOs only.
1478	4/69	Permit 40F2 emission by RACES stations on 144 and 220 MHz.
1479	5/69	Expand Extra phone bands.
1512	9/69	800W output above 420 MHz.
1516	10/69	Tech privileges, 21 MHz Novice band.
1520	9/69	CW and phone segments, 6 meter Advanced band.
1521	10/69	Technician CW privileges.
1526	10/69	Technician CW privileges, 10 meters.
1535	11/69	Technician privileges, 29.5—29.7 and 144—148 MHz; dual holding, Novice and Technician.
1536	11/69	Counterpart call signs.
1538	11/69	Higher RTTY speeds of 60, 67, and 100 wpm.
1542	12/69	New repeater rules.
1544	11/69	Extra class phone, 40 and 20 meters, or expand 20 phone for Extra.
1550	1/70	Expand phone bands, 80—15, half for Extra, half for Advanced.
1568	2/70	Novice privileges for Technicians.
1590	3/70	"Grandfather" old Extra Firsts.
1591	3/70	One-year wait for Extra.
1593	3/70	Amend incentive licensing frequency allocations.
1597	4/70	1 x 3 call signs for new Extras.
1602	4/70	Novice privileges for Technicians.
1603	4/70	Expand phone for Extra and Advanced.
1604	4/70	Change ID rules for short QSOs.
1614	3/70	Expand phone bands for Advanced and Extra; widen General Class phone; permit Techs on 28 MHz.
1615	3/70	Conditional Class limited to one year; no new Technician; create Intermediate and Communicator licenses.
1616	4/70	Expand phone, abolish reserved bands.
1629	5/70	Create a military examining point in Germany for FCC amateur exams.
1631	5/70	Specifically provide for discussion of political matters and other controversial subjects in the amateur bands.
1633	5/70	Create a "hobby" license 220.5—224.5 MHz, 5 kHz FM, FM, 100W, mail exam on rules only, NA1—NZØ call call signs.
1644	6/70	Expand phone bands for Advanced and Extra; widen the General portions of the present phone bands; reduce Novice band on 15 to 21.1—21.2, but add a new one 28.1—28.2; permit Extra class to use 7075—7100 kHz for SSB and add a note to the rules restricting 7100—7300 Hz work to Region 2 only.

For copies and additional information on these petitions, write to: (refer to RM numbers)

Amateur and Special Services Division
Federal Communications Commission
Washington, D. C. 20554

Ariz., Dr. William L. Sprague (WA6CRN), Whittier, Calif.; Dr. Walter Shriner (W9CBG), Springfield, Ill.; Dr. Edward A. Holyoke (WA0VSR), Omaha, Nebraska; Dr. Orin Q. Fling (WAZWAU), Delhi, N.Y. Sitting is Dr. J. Stanley Carp (K1EEG), Saugus, Mass. and directly behind him is Joseph G. Boris, Executive Secretary of MARCO.

QSL Manager of the Month

George Studd (ZL2AFZ) has been named QSL Manager of the Month by Scotty (WA5UHR), who makes such awards periodically on behalf of his QSL service.

According to Scotty, George is a great DX'er and a credit to our hobby. Along with several DXpeditions, he has traveled 45,000 miles, covered 33 states, 6 Canadian provinces, and visited the north Arctic circle and Alaska. When he was in the States he took over 1200 color slides, spoke on 2 TV shows, 2 BC stations, dozens of radio clubs, Kiwanas, schools, churches, etc. George has received a number of DX awards. He is QSL manager for VRIQ, ZL2AFZ/C, ZN1BN/A, ZM3PO/C, AXØLD, ZM1AAT/K, ZL2ANX. He was previously manager for ZL1DS/C, ZL1TU/C, and ZL1IL/c.



Nominations for QSL Manager of the Month should be sent to Scott's QSL Service, 1510 Lynnview, Houston, Texas 77055. Include name and call of manager to be nominated and a short summary of why he deserves to be nominated.

Alabama Hamfest Success

Eight hundred hams and their families braved the summer sun of Northern Alabama to attend the Huntsville hamfest on August 16th. The event, held in the air-conditioned splendor of the Huntsville Mall, was a complete success by any standards.

The hamfest started Saturday night with a talk by Wayne Green giving some perspective to the present situation of amateur radio in terms of its history, the ITU, and the FCC. Slides were shown of his recent trip to Jordan and his visit with King Hussein as well as a previous trip to Nepal. All questions were answered, pertinent and impertinent.

On Sunday there were RTTY displays, FM get-togethers, DX displays, a couple of acres of swap-fest, Bingo for the XYLs, and frequent showings of the Dave Bell film on amateur radio.

FCC REGULATIONS PROHIBIT CONTESTS!

ARRL in Chaos

FCC Amateur Radio Rules and Regulations Part 97.125 says, "No licensed radio operator shall willfully or maliciously interfere with or cause interference to any radio communication or signal."

Could that rule be clearer? No willful interference with any radio signal. That means exactly what it says. If you have even the slightest reason to believe that your signal might cause interference to another signal it is against the rules for you to transmit.

Contests, those giant exercises in willful interference, are obviously absolutely illegal.

The preponderance of contest activity in the U.S. is sponsored and promoted by the ARRL. Since we must assume that the directors and officers of the League are familiar with the amateur regulations, then the only conclusion possible is that they are knowingly promoting and encouraging an illegal activity which causes tens of thousands of amateurs to break the FCC regulations.

DX Pileups Illegal

If it is illegal to cause interference to one station, just think how illegal it must be to cause willful interference to dozens or even hundreds of stations. Think about that the next time you are about to add your potent signal to a pileup calling a rare station. Is working that station really worth the torment you will suffer knowing that you have committed multiple violations of the regulations, not to mention the suffering and anguish you have caused the poor chaps on the channel whom you clobbered. One would have to be a pretty lawless and callous individual to chase DX in view of all that.

WIAW Breaks Regulations

Yes, even sacrosanct WIAW is in continuous violation of 97.125. Just tune in anytime to the broadcasts of League affairs and you will notice that WIAW comes on frequency on schedule and causes willful interference until everyone moves off channel for them.

Is This Serious?

The law is the law and many bleeding hearts feel that all laws should be observed, no matter how inappropriate they may be. When a law is bad the question arises, should we ignore the law or try and change it?

The idea behind 97.125 is fine and the law will cause little trouble if everyone continues to ignore that it exists. Unfortunately, the lid has been opened recently by the FCC. Two amateurs, both calling a third station simultaneously, with the goal of seeing which had the strongest signal, received an FCC citation citing 97.125.

The cure is simple. If one of you will write a letter to the FCC, with the usual 14 copies, asking that the words "willful or" be removed from 97.125, then we would have the same law, but without the bad part.

New DX Certificates Available from 73

WORKED NORTH AMERICA

Card confirming two-way contact with amateurs in each of the following areas must be furnished: W1 through WØ, KL7, VE1-8, including separate cards for PIE, CBI, NS and NB in VE1, FP8, VP7, and both Yukon and NWT in VE8, a total of 27 cards. Cards should all be dated 1970 or later.

WORKED CENTRAL AMERICA

Cards confirming two-way radio contact with amateurs in each of the following areas must be furnished XE1-2-3, XF4, VP1, TG, YS, HR, YN, TI, HP, KZ5 (a total of 12 cards). Cards should be dated 1970 or later. It

DX NEWS ROUNDUP-NEWS FROM ALRANIA

From the West Coast DX Bulletin comes this late report filling in details on the OH/ZA effort. The OH group drove by car some 700 miles to Copenhagen and flew directly from there to Tirana. No answers had been received to their letters of inquiry for information and they went on the trip to see what might be accomplished. At customs they were passed through without any examination and they carried their rig to their hotel. They then learned that they would not be permitted to go on to Tirana. With the help of their Albanian guides they set up their antenna and started working the pileups. This lasted for about nine

During the balance of the stay the OH group tried to get a special visa to visit Tirana and discuss the situation. Direct efforts did no good, but finally the Albanian guides were persuaded to make arrangements which would permit them to visit the Albanian capitol. They went there on the last day of their stay and had a one hour meeting with the vice director of the Ministry of Communications. They learned that their letters had been received, but had not been answered because there was no provision for amateur radio in Albanian law, it being neither allowed nor prohibited. He asked that more information be sent before any future



Rogues Gallery. *This photo of C. R. Lander (ZL3ACY) won first prize in a recent competition sponsored by the North Canterbury Amateur Radio Club, Canterbury, New Zealand. As winner, Lander received a subscription to 73 Magazine and his photo appeared in several international publications.*

is the areas that are important, so special call prefixes are acceptable.

WORKED THE CARIBBEAN

Cards confirming two-way amateur radio contact with each of the following areas must be furnished: KS4 Swan Island, KS4 Serrana Bank, KS4 St. John, VP2M, VP2S, VP2V, VP5, FG7, FM7, FS7, PJ St. Martin, PJ St. Eustatius, PJ Aruba, PJ Curacao, PJ Bonnaire, PJ Saba, 8P6, 6Y4 Trinidad, 6Y4 Tobago, YVØ, HKØ San Andres, HKØ Baja Nuevo. Cards should be dated 1970 or later. Certificates are available for 20, 30, and 40 areas worked.

WORKED SOUTH AMERICA

Cards confirming two-way amateur radio contact with each of the following areas must be furnished: HK, YV, PZ, SR, FM7, PY, LU, AP, CE, HC, OA, CP and CX, a total of 13 countries. All cards must be dated 1970 or later.

WORKED EUROPE

Cards must be furnished confirming two-way amateur radio contact with each of the following areas: G, GM, GW, GI, GC Jersey, GC Guernsey, GD, EI, F, D, DL7, DM, EA, EA6, FC, C31, HB, HE, OE, OK, HA, YU, OZ, LA, SM, OH, OHØ, OJ, CT, YO, AZ, SV, SP, I, M1, HV, IS, IT, SVØ Crete, SVØ Dodecanese, LZ, TF, OY, ON, PA, LX, ZB2, 4U (Geneva), 9H1, TA (European), SMOM, JX, JW Svalbard, JW Bear, UA2, UA, UB5-UT5, UC2, UD6, UF6, UG6, UO5, UP2, UQ2, UR2, a total of 65 areas. Certificates are available for 50, 60, and 65 areas.

Contacts may be made on any amateur bands using any mode. All cards must be dated not earlier than 1970. Send cards with note describing certificate applied for and listing the areas confirmed along with one dollar to cover the cost of handling. Send to 73 Magazine, Peterborough, N.H. 03458. Foreign amateurs may apply through their national societies and send along an affidavit attesting to the inspection of the cards and seven IRCs.

hours.

The next morning the Albanian authorities were at the door, apologizing for not having noted the declaration of the radio gear on their entry. They advised that the bringing of radio into the country was prohibited and the equipment would have to be held until they left the country. The operation was over by 0700Z on July 11th.

The Albanians had apparently set up a monitoring station about 200 yards from the hotel before the visit. The transmissions were recorded and checked by English-speaking Albanians. The OH group kept all transmissions in English, commenting favorably on the Albanians and their treatment at frequent intervals. Whenever they left the hotel they were followed. Why was the rig impounded? Perhaps the authorities wanted to examine it or possibly they were not anxious to sit and monitor the pileups for a full week. It was returned in good condition. In retrospect the OH group felt that the decisive factor in the future Albanian attitude would be what benefit the country might derive from amateur activity.

Looking ahead, the OH group are making plans for another effort in June 1971. Documentation has been forwarded to ARRL and DXCC credit is expected. Some 600 W/K's were worked. The OH group is grateful to the International DX Association for making a modified HW-32 available for the trip.

Canada–Sweden Reciprocity

Ottawa. Canada's director of Telecommunications, Mr. W. J. Wilson, has announced that his country is now recognizing reciprocity with respect to "temporary amateur operating privileges with Sweden." For Swedish permits issued for a period of less than 30 days, Wilson stated, the fee is 40 Swedish kroner. Wilson also supplied the following excerpt from the Code of Statutes of the Swedish Telecommunications Administration:

Any foreign radio amateur applying for a temporary permit . . . shall submit his application via the authorities issuing permits in his native country, which authorities will forward it to the Central Administration of Swedish Telecommunications together with their comments. The application, which may be written in Swedish, Danish, Norwegian, English, French, or German, should be submitted early enough to reach the Central Administration not later than two months before the permit is required. It shall be accompanied by a certificate of good conduct issued by the police authorities of the applicant's native country.

QSL Delays

A note from Garth (5H3LV/A) explains that QSLs for the Zanzibar expeditions have been delayed a bit due to their being sent to U.S. QSL bureaus during a Canadian postal strike.

A cable from King Hussein tells us that all QSLs for JY1 have been forwarded through the bureaus.

While most of the individual bureaus work quickly and efficiently, the biggest holdup seems to be at ARRL headquarters, which reportedly holds cards up to six months or so before sending them along to the individual bureaus.

Haiti Active for DX Contest

by W6GC

W6WLH, W6EJJ, and W6GC will be operating HH9DL during the CQ worldwide DX contest on October 24 and 25. They will operate 5 bands, 10 through 80 meters, for the entire 48 hours of the contest. There are no particular frequencies chosen as yet, but some operation will be outside the American phone bands using split frequency. For a part of the time the listening frequency will be in the General portion of the bands so everyone will have a chance.

This is reportedly the first time any Haitian station has operated the contest. The group plans to arrive in Haiti about October 20 and will be on the air both SSB and CW for about 3 days before the contest.

Canada–U.S. CB Reciprocity

Under an agreement between the United States and Canada, effective July 24, 1970, visiting Canadians who hold valid Canadian licenses in the general radio service may request permission to operate their radio stations in the United States.

Permission to operate their radio stations in the United States may be requested by completing an FCC Form 410 until November 1, 1970, at which time a new form 410-B will be available for this purpose. All applicants for such permission must have read and understood Part 95 of the Commission's Rules and all operation must be in compliance with these Rules. Canadians while operating in the United States under such authority must identify their stations by their Canadian call sign followed by the station's geographical location (city and state).

73's New Award Lineup

A whole new spectrum of certificates are being awarded by 73 for amateurs who manage to fulfill the stated requirements – which won't be easy.

Worked the ARRL Certificate

This award is available to any licensed amateur who can provide proof of contact with any four of the current sixteen ARRL directors, all within one year of the date of application. Stickers are available for proof of contact (within one year) of eight or twelve directors, with a special sticker for proof of contact with all sixteen directors. A special sticker is available for proof of contact with John Huntoon W1LVQ, manager of the ARRL, at any time on any band.

Please send $1 to cover costs of postage and handling of this award or sticker. 73 will consider it a news event of the first order when the first 16-director certificate is awarded and asks that you have a photo of yourself and your shack available, along with a brief biography and a story on how you accomplished the seemingly impossible.

Worked CQ Certificate

A beautiful illuminated certificate is available to any licensed amateur who can provide proof of contact with the editor and managing editor of CQ Magazine, K2MGA and K2EEK, both within one year of the application for the award and both through chance, not scheduled contacts. Please send $1 to cover the costs of mailing and handling. . .and good luck!

Worked Ham Radio Certificate

A new and exciting award is available for licensed amateurs who can

Worked QST Certificate

In an effort to promote activity on our amateur bands where little or none existed before, and to bring prominence to a handful of amateurs who were almost completely obscure, despite their untiring efforts to be well known, we are offering a set of awards suitable for framing. Probably the rarest of all of awards will be this gem, available to any licensed amateur who can provide undeniable proof of contact over the air on a chance, not scheduled basis, with both the editor and managing editor of QST, W1LVQ and W1CUT. Both contacts should be within one year of the application for the award. Please include one dollar to cover the costs of mailing, handling, and medication for any ill effects caused by anoverstraining of credulity by the 73 staff.

MALL DISPLAY

To Increase Public Ham Awareness–

Several radio clubs in the Southeastern Pennsylvania area have gotten together for the purpose of putting on a display of amateur radio equipment, and uses of ham radio in helping the nation and public. The display will be known as the "MacDade Mall Amateur Radio Display" and will be held Sept. 17–19 at the MacDade Mall, Glenolden, Penna.

Several MARS stations will also be in live action.

Hallicrafters Wins Cleveland FM 2-Way Contract



Lieut. Gen. Benjamin O. Davis, Jr., Director of Public Safety, City of Cleveland, points to a diagram of Cleveland's new police communications network. A vital link in the system will be the new HC-400, UHF portable radios for which Hallicrafters was awarded a contract. Shown at the extreme left: Lewis Coffey, Cleveland police chief holding the Hallicrafters HC-400 with which his policemen will be equipped; Walter Sutter, Hallicrafters vice president and general manager; Safety Director Davis; and Bob Long, Hallicrafters' Sales Manager.

provi e proo o contact wit ot t e editor and publisher of Ham Radio magazine, W1NLB and W1DTY, both within one year of the application for the award and both through chance, not scheduled contacts. Please send $1 to cover the costs of mailing and handling.

Worked 73 Certificate

If you manage to get contact and, even more difficult, get a QSL from both W2NSD/1 and K6MVH/1 you have the privilege of sending in one dollar for a certificate of questionable value which may lend some dignity to your effort. Contacts should be within on year of the application and be through chance, not schedule. Don't forget the dollar. . .we won't.

K3WAS Award

On Wednesday, 11 November, K3WAS, a military amateur radio station at Aberdeen Proving Ground, Maryland, will be operating in conjunction with Veterans Day. A very attractive commemorative certificate will be mailed to all persons who contact K3WAS on this day. The operating schedule is as follows:

50.3 MHz +.3 MHz 0001–2300 GMT
14.320 MHz ±10 kHz 0001–2300 GMT
7.280 MHz ±10 kHz 0001–2300 GMT
3.970 MHz ±10 kHz 0001–2300 GMT

To qualify for a certificate, just make two-way contact with K3WAS and send QSL card to K3WAS, Special Services Craft Branch, Aberdeen Proving Ground, Maryland 21005.

"Big Blow" Award

The Windblowers VHF Society will sponsor the 16th annual "Big Blow" contest on Saturday, September 19, 1970 from 13:00 to 20:00 EDT. There will be four stations operating on 2 meters. Certificates will be awarded to those contacting all four stations.

Location and call letters will be as follows:

W2ZDR/2 Washington Township, NJ
W2RRP/2 Sam's Point, NY
WA2ZAU/1 Topstone, CT
W2ERZ/3 High Knob PA

TAWAS Hamfest

The Iosco Amateur Radio Club is again presenting its Annual "Tawas Hamfest" in Tawas City, Michigan this year. The affair will be featuring a gigantic "swap & shop," equipment displays, banquet, Ham-of-the-Year award, and auction. The hamfest will take place on U.S. 23, 60 miles north of Bay City. Plenty of activities for the ladies, such as: boat trips, air base tour, ladies luncheons. Bring the family for a weekend of fun. Addition information: Hamfest, Box 3321, Jeff. Sta., Detroit, MI 48214.

"HISTORICAL" CONFERENCE SLATED

National Amateur Historical Radio Conference, Canandaigua, NY, Oct. 9th and 10th, sponsored by the Antique Wireless Assn. Program includes well known speakers from coast-to-coast, early transmitting and receiving demonstrations with prizes plus old equipment auction. In addition to amateur programming, there will be special events for the oldtime commercial and broadcast operator. Write for details: Lincoln Cundall, W2QY, 69 Boulevard Pkwy., Rochester, NY 14612.

The City of Clevel nd, Omo a awarded Hallicrafters Co. a contract for approximately $750,000 to supply Model HC-400 FM 2-way portable radios operating in the newly expanded 450 MHz frequency band for its police department's new communications system.

When signing the contract, Lt. Gen. Benjamin O. Davis, Jr. (U.S. Air Force, retired), Director of Public Safety, City of Cleveland, said that the Hallicrafters award was based on the "most cost effective bid" submitted for portable FM units. Hallicrafters was awarded the Cleveland portable radio contract in competition with Motorola and the General Electric Co.

The new HC-400 is small, light, and utilizes integrated circuits and the newest discrete components. Helical resonators are used instead of coils in critical rf circuits to give the high performance required in the newly assigned UHF frequency bands.

The 856 UHF type radios to be supplied (Hallicrafters Model HC-400) are an advanced communications design developed by Hallicrafters engineers. Each unit is battery operated and provides a minimum of 2W rf power output with a battery life of 8 hours at a 10–10–80% duty cycle. Each unit has 4 transmit and receive channels and is equipped with continuous tone squelch. The Cleveland version of the Hallicrafters HC-400 utilizes an external wearable speaker/microphone/antenna combination. All three functions are combined in a compact unit that can be handheld or worn on a quick-disconnect patch attached to a policeman's uniform.

The Hallicrafters HC-400 personal portable FM 2-way radio is designed to work as an integral part of the "new trend" Cleveland police communications system operating in the UHF band. The prime contractor for the system is Page Communications Engineers of Washington, D. C.

Morro Bay Award

The Estero Radio Club of Morro Bay, California, announces the Morro Bay centennial award, in honor of Morro Bay's 100th year. The centennial celebration runs from July 1970 to July 1971. Contacts for the award must be made within this period. To obtain the award, work eight stations in San Luis Obispo County, including three members of the Estero Radio Club. Any mode and any band may be used.

The members of the club include – K6TOE; WB6s: BNF, JTA, STG, TYR, PPZ, ZRR, ECM, ROG, PGK, SBH, VKN, YCH; WA6s, DDQ, DEI, FHV, GOR, MGG, QDA; and WN6s, DHS, KOG, NFB.

Send a list showing stations, times, and frequencies and $1 to WA6DEI, custodian, Box 1118, San Luis Obispo, CA 93401.

If It Ain't One Thing It's Another!

Two issues back 73 published a new-product writeup describing the FM Schematic Digest, a comprehensive sourcebook of Motorola transmitter, receiver, and power supply schematics. The only trouble with the writeup was that a price of $3.95 was quoted, while the *actual* price is $6.50. As might be expected, myriads of customers complained to the publisher that they had been overcharged. The publisher, in turn, asked 73 to rectify the situation by printing a retraction. This is it. Please, all you FM enthusiasts out there in Radioland, stop bugging the people at Two-Way Radio Engineers, Inc., 1100 Tremont St. in Boston. It wasn't their fault. Besides, $6.50 is a mighty good price for 136 extra-large pages of Motorola circuit diagrams, alignment dope, and crystal ordering info.

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. Include your check with order.

Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

For $1 extra we can maintain a reply box for you.

We cannot check into each advertiser, so Caveat Emptor. . .

FOR SALE: Brand new Gonset Communicator IV, 2 meters. Complete with manual, $250.00. Certified check or money order. Tim Gysan, 53 Lothrop St., Beverly MA 01905.

TIME BASE CRYSTAL OVEN. Center temp. 75°C. Cycling .05°C. 115V ac. 1½" dia. x 3" tall. Octal base. Holds HC-6/U xtal. Made by Ovenaire. Replacement for Berkley Counters. $10.00 includes shipping. Never used. Guaranteed. Yellow Cab Radio Dept., PO Box 587, Kansas City MO 64108.

SELLING: $230 of radio gear. Hallicrafters SX120 general receiver, $30; October 24, there will be a get-together and technical program presented. There will be no charge or other fee made to attend. For particulars write A. C. Harbin WA5LWT, 204 Cedar, Brownfield TX 79316.

BEST OFFER: Hammarlund HQ-110, Heathkit supply HWA-17-1, Monarch FS1-3, B&W 75 ohm filter, 73 Magazine from 1st copy. Roy A. McCarthy K6EAW, PO Box 3712, Anaheim CA 92803.

SWAN 250, 117 xc supply, TV2B (new), SB500 transceiver, Clegg Venus xcvr, 416 ac supply. SASE for details. Scotty, 14534 Vaughan, Detroit MI 48223.

HW12, 22, 32. Owner: Convert your rig to three band SSB/CW transceiver. Construction manual, $3.00 ppd. Camelot Company, 215-28 Spencer Avenue, Queens Village NY 11427.

NATIONAL 1000, one kilowatt transceiver, 80—10 meters, brand new, used for short test for 73. Cost $1100. Send check for $900 and it is yours. Factory guarantee. 73 Magazine, Peterborough NH 03458.

AMATEUR EQUIPMENT REPAIRED, calibrated, kits assembled and aligned, de-bugged by holder of Amateur and First Class Commercial FCC licenses. Write Tom Hopkins, Box 396 Faison NC 28341.

FACSIMILE MACHINES: RD92A/UX and TXC-1B. Your choice, with 100 sheets paper, $125.00. Need Mite motor. F.K. McGinnis, 4304 McFarlin Blvd., Dallas TX 75205.

WANTED! Numerous back issues of different radio magazines. Huge Free List. Trading old radio shows, airchecks, interested in commercial movie material. Thomas King, Auxier, Kentucky.

DRAGON FLY. . .antenna, for 20-40-75 meters. . .no traps. . .no compromise. . .eight months in development. . .one feed line. . .SWR one to

SWAN 250, power supply, xtal calibrator, S-meter, in original cartons $300. Getting TR-6. K1FMU/WB8FVL George Dessert, RFD 4, Parkersburg WV 26101 (304-863-5405).

SWAN 250, power supply, xtal calibrator, S-meter, in original cartons $300. Getting TR-6. K1FMU/WB8FVL George Dessert, RFD 4, Parkersburg WV 26101 (304-863-5405).

WANTED: Used MN-2000 Drake Matching Network. Must be in mint condition and reasonable priced. Edward Kovalan, 227 Wildwood St., Clarksburg WV 26301.

GREAT BRITAIN to the U.S.A. Let us quote you for any equipment or components. Free lists available. Enquiries answered by return Air Mail Post. We require good clean job stocks of electronic components. Elekon Enterprises, 12A Tottenlam St., London W1P 9PQ, England.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class License, plus "Self-Study Ability Test," Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

TEST EQUIPMENT: Signal Generators: Meas. 80, 2—400 MHz, $250; URM26A, 3—405 MHz, $225; Meas. 65B, 15 kHz, 50 MHz, $350; HP608A, 10—500 MHz, $425. Counters: Berkeley 5500, Univ. EPUT, 100 kHz, $165; HP524B, 10 MHz, $495; HP525A, 10—100 MHz plug-in, $115; HP626B, Time Interval plug-in, $95. All guaranteed. Many more, send SASE for list. Grattan Gray, PO Box 941, Monroe MI 48161.

NEW SB 400 xmtr w/xtal pak, never used and factory aligned, $300; NC 303 reconditioned and beautiful, $200; Collins mint KWM1, ac, dc, and mobile mount, $325; Collins KWM 2, 6 months old with CC2 case and ac power, $750. Need 2 kW linear and will swap. WB8FUG, PO Box 23, Conway MI 49722.

LISTING SERVICE — gear to sell? Need rig? Sellers, $1.00; lists information year. Buyers, free. SASE brings details. W8TXX listing service, Box 1111, Benton Harbor MI 49022.

DTL INTEGRATED CIRCUITS: Guaranteed new: gates 70¢, buffers 80¢, F/F 90¢, dual F/F $1.15. Add 20% postage. SUMMER SPECIAL: subtract 10% discount, September only. Mitch-Lan Electronics Co., Dept. 1070, PO Box 4822, Panorama City CA 91402.

TECH MANUALS: R-390/URR, R-390A/URR, TS-186D/UP, BC-639A, R-274/FRR, ARR-7, $6.50 each; TS-174/U, TS-175/U, TS-323/UR, $5.50 each. Hundreds more. S. Consalvo, 4905 Roanne Drive, Washington DC 20021.

RG8U or RG11U: Low loss foam coax 10¢ foot. PL259, SO239 40¢ each. 15/$5.00. Jacketed ½ inch aluminum 50 ohm Foamflex 20¢ foot. New Ham-M Rotor $95.00. Everything new! Monte Southward, Co. RD 51, Upper Sandusky OH 43351.

FOR SALE: Best offer DX 100, SX100, DX 40, Globe 90, TBS 50, BC 348, RCA 88LF, ip501, Marconi LF, Omega 4x5 enlarger, HT40 RCA 8506B, AR 8503, all in working condx. Write Box 8352, Savannah GA 31402.

NOVICE CRYSTALS: 40-15M $1.38, 80M $1.83. Free Flyer. Nat Stinnette Electronics, Umatilla FL 32784.

TELETYPE PICTURES FOR SALE: Volume 2, 16 pages containing 50 pictures $2.00. Volume 3 coming $1.50. Also audio and perforated tapes. W9DGV-c, 2210-30th St., Rock Island IL 61201.

TAMPA HAMFEST Lowry Park, Sligh Ave & Norht Blvd., Tampa, Fla., Sunday, October 11, 1970. Lots of prizes; plenty of free parking. Fun for all.

Heathkit HW30 twoer ground plane and beam, $50; Clegg 99er for six meters and Drake T100 high-pass filter and six meter beam, $90; antenna rotator and mast, $60. Howard Applegate, 159 Sheridan Square, Brigantine NJ 08203. Phone: YO9-266-3106.

CHARTER JET FLIGHT to SAROC. Roundtrip New York City to Las Vegas $229.00, depart JFK 10:00 a.m. January 7th. Roundtrip Chicago to Las Vegas $199.00, depart O'Hare 12:00 noon January 7th. Return January 10th. Includes meals and drinks aloft, Flamingo Hotel Room three nights double occupancy, transportation and baggage in and out of Flamingo Hotel, dinner show, midnight show, Saturday buffet luncheon, Sunday buffet breakfast, SAROC tickets, tax and gratuity. $60.00 will confirm reservation, includes one dollar service fee. Final payment due before November 25th. Flight cancellation or written request for deposit refund will be accepted until December 1st. SAROC, Box 73, Boulder City NV 89005.

ATTENTION: Galaxy V Mark 2, A.C., Console, V.O.X., $370. Gonset G-50, $150. CV-71 T.U., Lab Aligned, $65. Bill Handel K8SSY, 95 Murwood Drive, Chagrin Falls OH 44022 (216-247-6130).

HIGH-POWER MOTOROLA Handie-Talkie Motorola PT 300. Practically new. Two frequency. Tuned up and operating perfectly on 146.76 and 146.94. Includes mashbar handset with curlycord, crystals, new nicad rechargeable battery, battery charger. Puts outs about 6.5W. Receiver sensitivity 0.25 μV. A steal at $325 and the first check buys it. Manual included. Ken Sessions, 73 Magazine, Peterborough NH 03458 (603-924-3873).

TERRY COUNTRY AMATEUR RADIO CLUB will hold its 16th Annual Hamfest and Swapfest on Sunday, October 25, 1970 in the National Guard Armory, Brownfield, Texas. For those who come early on Saturday one guaranteed. Construction drawings $5.00. Box 423, Wakefield RI 02880.

RBB-RBC MANUALS, New, $5.00; Used, $4.00. OS-8 oscilloscope manual, $3.00. Some QST 1929, 30, 31, etc. Radio 1939, 40, 41, etc. Write for list. James W. Holloway W6LFL, 2027 Harton Rd., San Diego CA 92123.

SAROC January 7—10, 1971, Flamingo Hotel Convention Center, Las Vegas, Nevada. Sponsored by Southern Nevada ARC, Inc., Box 73, Boulder City, Nevada. Advance registration $14.50 per person accepted until January 4, regular registration at door, includes Flamingo Hotel Late Show and drinks, Sunday breakfast, cocktail parties, technical seminars and meetings, ARRL, DX, FM, MARS, QCWA, WCARS-7255, WPSS-3952, and WSSBA. Ladies Program. Flamingo Hotel SAROC room rate $12.00 plus room tax, per night, single or double occupancy January 3 thru 12, 1971. Mail accommodations request to Flamingo Hotel. Mail advance registration to SAROC. W7PRM, Club President. W7PBV, SAROC Convention Chairman.

GREENE. . .center dipole insulator with. . .or. . .without balun. . .see November 73, page 107.

SELL or trade for ham equipment: H/P micro-wave instruments; 415B $50, 416B $75, 430C $75, plus shipping. WA8JEH, 23 Coolidge Ave., Columbus OH 43228.

HALLICRAFTER HT-33 kW linear (needs 2 tubes) $75, HT-30 Exciter $75, Drake 1A rcvr. $100, all for $200. Phil Windolph W9NEP, 10737 S. Michigan, Chicago IL 60628.

SELL: Two Synchro Tape Machines (Remington Typewriter/Friden Tape/Card Punch and Reader) $150. Operation instructions and manuals for Friden units only. Some tape and cards included. Complete description in late 1968 issues of 73. Tektronix 511AD $95. Tektronix 514AD $150. Manuals, probes, and some spare tubes included.

30 WATT SSB TRANSISTOR

A new single-sideband transistor furnishing 30W PEP across the 1.5 to 18 MHz band is announced by TRW Semiconductors. The new PT6738 has a gain of 13 dB and intermodulation distortion guaranteed 30 dB or better. Operating voltage is 28V. The unit is in the TO-59 package which is compatible with the TO-60. The new transistor is a product of TRW Semiconductor Division, Communications Transistor Plant, 14520 Aviation Blvd., Lawndale, Calif. 90260.

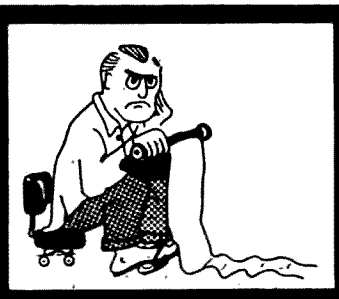


Representatives from five major distributors of Signal/One's Model CX7 transceiver inspect the new radio in a familiarization seminar at the Signal/One facility in St. Petersburg, Fla.

From left are Otto Hagendorff of Harrison Radio Corp., New York City; Park il Young of Henry Radio Stores, Los Angeles and Anaheim, Calif.; Signal/One's Charles Brock; Doug Murray, owner of Amrad Supply, Inc., Oakland, Calif.; Miles Cundy of Amateur Electronic Supply, Milwaukee, Wisc.; Signal/One's Amory Planchard; and John Capone, owner of CW Electronic Sales, Denver, Colo.

The Signal/One program is a part of the Data Communications Group of Electronic Communications, Inc.

The CX7, described as a "deluxe integration station in a single compact package," incorporates many new design features, most of which stem from the application of advanced aerospace electronic technology to the amateur radio field.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

A note from one of the officials running the ARRL National convention in Boston explained that Huntoon again has forbidden them to allow anyone from 73 to appear on any program.

There being more than one way to skin a cat, we have arranged to have an auditorium room at the convention in which to run our own program. This is more than sour grapes, judging from the number of letters we have had asking if we were going to be able to show my slides of King Hussein, if Ken were going to be able to organize an FM repeater forum to coordinate action for getting the proposed FCC regulations straightened out, etc. There are a number of things that should be brought up for discussion at the National Convention and we intend to bring as many up for discussion as possible.

To those of you familiar with the usual ARRL open forums, let me say that the forums we organize will not be the rigged affairs that you have experienced in the past. I have yet to see an ARRL forum that didn't appear to be meticulously planned with the end of preventing the members from asking any embarrassing questions.

If you have any ideas for forums that would be of benefit to our hobby please take the time to work out some details on your ideas and send them to me.

The schedule of talks in our room . . . room 437 . . . will be available at the 73 booth. Among some of the talks and forums being scheduled are the following:

DX coffee klatch
160–80 DX forum, KV4FZ moderator
Foreign visitor get-together, YO2BO moderator
Forum: Where do we stand with the ITU?
Forum: Do we need more phone allocations?
FM coffee klatch
Forum: FM repeaters and the FCC
Forum: FM the state of the art.
Forum: Do we need a Washington lobby?
Forum: 146.76 or 146.94 as a repeater output?
Forum: DX
Slides: Trip to Jordan and JY1
Slides: Visit to Arecibo and the big dish
Slides: YA-YK-YI-EP
Slides: FK-VR2-5W-KS6-FO
Forum: Mandatory tone for repeater control?
Forum: VHF
Forum: RTTY
Forum: Moonbounce
Forum: New blood for amateur radio?
73 boosters open house (cider–doughnuts)
Forum: Incentive licensing?

It is hoped that all sides will be present for the open forums so that the best thinking of everyone involved can be used to provide solutions to our problems. We plan to record these forums and present the highlights of them in future issues of 73. We will do what we can to see that a representative of the ARRL is present at all forums to provide an explanation of the official ARRL explanation for what has been happening.

Since most of the action of the convention is on Saturday we have scheduled all of the activity on our program for this one day.

Schedule Canceled

In the August issue of 73 I announced that I would be standing by as nightly as I could on 14.300 at 0200 GMT for anyone with any traffic for me, particularly for news items that might be of value for the news pages.

After trying this scheme for a little over a month and meeting the schedule most nights, I can see that it is time to call a halt to this madness. The interference in this General part of the band is beyond belief and more than I care to continue to face. Sure, I can hear the fellows in there calling me, but the noise from other stations is so bad that I can't even get call letters through unless the caller has a kilowatt and a good beam to back him up.

The General class operators who are trapped up in that 75 kHz of the band have more patience than I. The Advanced part of the band is relatively free of interference and the time is rare indeed when I can't find a reasonably clear channel there for working DX. I suppose that it is a lot easier to put up with the mess in the General section of the band than to try and change the band.

It is not likely that I'll be missed too much on 14.300 as one signal more or less on the channel

(cont. on page 31)

AN
EDITORIAL
by
DAVE MANN K2AGZ

Leaky Lines

1 DANIEL LANE, KINNELON NJ 07405

According to a report in a recent issue of Popular Electronics, one of the CB clubs has established an office in Washington for lobbying purposes. The item also states that a nationwide CB organization is probably in the offing, to be coordinated into a program through which they hope to influence the actions and attitudes of FCC. They claim to have an ex-White House staffer and several Texas Congressmen interested in Citizen Band Radio.

There can be little doubt that such an organized lobby, if properly financed and well connected politically, can become a strong force in representing the more than 875,000 persons licensed in that service. But what about us hams? What will happen to the Amateur Radio Service if the CB interests succeed in gaining an inside track, and we continue to go on, living in a fool's paradise?

At 73, Wayne has been advocating a change in perspective for a long time. There are many valid reasons why the American Radio Relay League ought to change its inflexible opposition to the idea of representation in the nation's capital. It is no longer enough to maintain a *laissez faire* attitude toward this necessary change on the sole ground that we must preserve a tax-free status for the organization. While it may be perfectly true that the League saves a great deal of money through this posture, if we were to lose prestige in the eyes of legislators and members of the FCC, merely because of our failure to propagandize (and yes, wheel and deal) with persons who simply do not recognize that there is a vast difference between amateur radio and Citizen Band radio, we are a cinch to wind up holding the smelly end of the shaft. No matter how exalted the position in government a person may hold, he cannot be ex-ected to suck the true picture from his thum There are some very intelligent people who still do not know that we are different from CB'ers, and they actually think that persons who run the little five-watters are ham operators. They simply have no idea that we are a group which participates in a wide spectrum of public service activity . . . and how in the world could they be expected to know the truth if nobody points it out to them?

It has become more urgent than ever for the League to get off its duff and begin to do something about this. We can straighten out our image in short order if only we forget about our own exalted opinion of ourselves. We must get over the idea that we are above getting our hands soiled . . . that we are too good to engage in struggle with our adversaries . . . that we must not show bad manners by sinking to the low level of others. There is absolutely nothing to be gained by sneering and making snide remarks about the 11 meter bunch. While we are scoffing and ridiculing them among ourselves, they might very well be getting some naive Congressmen to pressure FCC for additional frequency grants, and I would just like to ask you, where would that increased spectrum come from? I'll give you three guesses!

We cannot rely upon "The Ham's Wide Wide World" to do the job. It does some good, of course, but it's simply not enough. Ten, twenty, or thirty films like it would also be good, but would not be enough to handle the job. We have got to embark on a much broader program of public education and orientation, which will penetrate into the consciousness and awareness of this entire country. We have got to make sure that everyone in America recognizes that amateur radio contributes toward the general welfare and health of our nation, and it is a viable and indispensable part of our system. We must point out, so that all our people know it unmistakably, that ham radio is not a toy or an idle pastime for a set of superannuated playboys, retirees, and young kids. There are far too many folks in this country who think that ham radio is like stamp collecting, bowling, fishing, kite flying, and other such recreational hobbies. They must be made to realize that amateur radio is a meaningful activity which is vital and necessary to the ongoing development of our society. This can only be accomplished through public education on a wide and universal scale.

It does us little good to proclaim to each other, either verbally or in our own ham publications, which are rarely read by outsiders, how much good we do in programs like AREC, RACES, MARS, or in all our other work. We already know all of that. We don't need convincing. It is the general public and those who represent them in government who must be made aware of it! If we fail to get off our fat behinds and do some missionary work, we may find

(cont. on page 94)



There's an ugly rumor floating around about an idiotic FCC interpretation of what constitutes misuse of spectrum; and if the rumor is proved true, the new bad guys will be the Feds in Washington. And the good guys will include Wayne Green and John Huntoon, as well as all the ham operators who participate in service and medical-aid nets.

The to-do started when the FCC lowered the boom on the eye bank net. According to the Feds' new interpretation of an overapplied ruling, such operations are now illegal. The FCC dropped a note to some of the fellows in the eye bank net and advised them that their hamming was "for the use of" an organization, and was thereby an improper operation.

At the League, Huntoon got wind of the flap and protested to the FCC. The West Coast DX Bulletin also made noises of dissent. But so far the cries have gone unheeded, and the eye bank net – as well as thousands of other service groups – stands on the verge of disbanding. Huntoon voiced his comments to ARRL directors in a general letter last month, stating that the FCC is in effect actually reversing its prior policy of encouraging service organizations.

"These newest interpretations," Huntoon said, "strike at the heart of organized amateur radio in denying our right to continue to engage in such activities as voluntary communications for most boat races, parades, car rallies, charity drives, election results, eyebank network, and the like. . .

And from the West Coast DX Bulletin came the comment: ". . . it would be wise for every amateur – DX'er or otherwise – to watch this matter, keep informed of developments, and support the ARRL in its protests to the FCC."

To give the devil his due, I must say that in this issue, the League must be supported. John Huntoon is right in his reference to the new threat to organized ham radio. The FCC must be made to see that these service functions and organizations are the stuff that hamdom is all about. The consideration that I think should be foremost in the minds of the Feds is the one stipulated most clearly in the FCC rules – about the principal purpose of amateur radio being for the convenience, necessity, and in the best interest of the public.

If the eye bank net is not in the best interest of the community, how can amateur radio itself be? Even the *Saturday Evening Post* has acclaimed the amateur eye bank net for its service to humanity. In a comprehensive story on the workings of the net, Max Gunther's Post article told of how the hams work with surgeons to win the race against blindness. The story goes, in part:

Early in the morning of May 2, 1963, at the Indiana University Medical Center in Indianapolis, a man died of a heart ailment. He was 57. During his lifetime he had become interested in new medical techniques for saving sight, particularly in the fact that parts of the eye can be transplanted from one person to another. Like a growing number of Americans, he had authorized surgical use of his eyes after his death.

The dead man's eyes were promptly removed, sterilized, packed in small glass bottles, and carried to the Indiana Lions Eye Bank in the same building. If, within 48 hours, an eye patient needen them, these eyes could be used. After that, they would rapidly deteriorate.

Later that morning in Iowa City, Iowa, a man visited eye surgeon Dr. Alson Braley. The patient was a dark-haired, handsome young engineer who worked for the Maytag Company in Newton, Iowa. Since his boyhood his left eye had suffered from an inflammatory condition which had damaged the cornea, the transparent outer covering of the eye. On this May morning the eye had suddenly become very painful. Doctor Braley found that the cornea had ruptured, and rushed his patient into the University Hospital. If the eye were not repaired before the day ended, it would be lost.

Doctor Braley's job was to cut out the damaged section of cornea and replace it with a piece of healthy cornea from a donor's eye – if he could find one. He telephoned the local eye bank, but they had no fresh eyes available that day.

Local eye-bank workers might have spent all day telephoning the 80 other eye banks scattered across the nation, and it could easily have been too late by the time the eyes were located in Indianapolis.

Fortunately for Doctor Braley's patient, a more effective link existed – a coast-to-coast network of amateur, or ham, radio operators who make it their hobby to provide emergency communications among the far-flung eye banks.

The staff of 73 joins the staff at ARRL headquarters in an appeal to the FCC to give fresh consideration to federal rulings and official interpretations. All amateurs working in public service and all amateurs who believe that public service is vital to the ultimate preservation of our hobby should voice their opinions to Mr. Bill Grenfell, FCC, 1919 M St. N. W., Washington, D. C. 20554,

. . . K6MVH ■

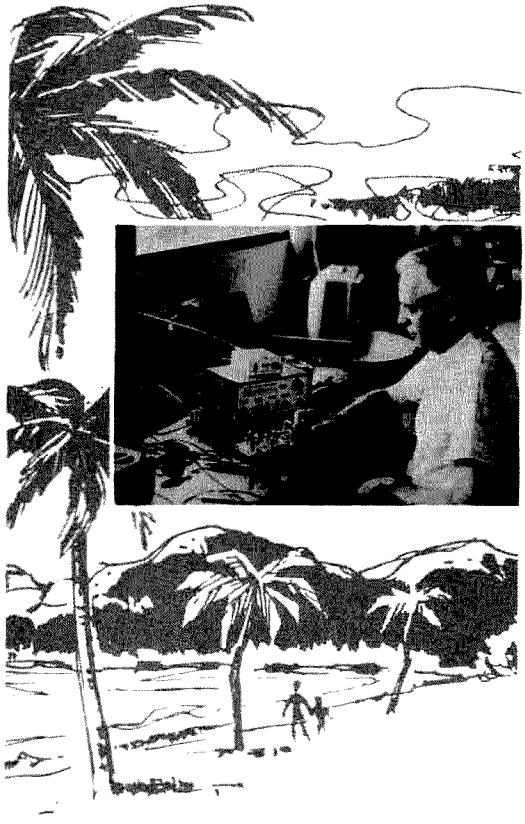
he worked the world.

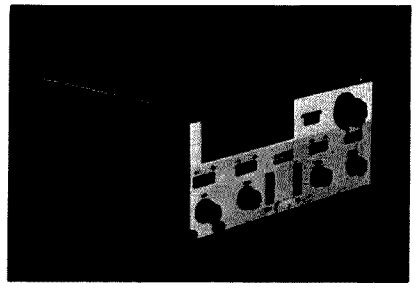
Mr. John H. Thompson, W1BIH/PJ9JT, recently packed his Ten-Tec Power-Mite PM 3A transceiver into a suitcase and headed for the Coral Cliff Hotel, Curacao (Netherlands Antilles). From there he worked the world.

"Final tally on the PM 3A results at PJ9JT are 261 QSOs on 14 MHz and 41 QSOs on 7 MHz for a total of 302. This includes 32 different countries in 5 continents. I operated only with the PM 3A on 7 and 14 Mc. CW. No contacts were set up first on high power, nor was any auxiliary receiver used. It was all done with the PM 3A. Of course I had a FB location and the call didn't hurt. Among the DX worked were five VKs, a ZL, VU and 4X4. Only Africa was missed and I did get a PJ? response from an EL. The batteries, a pair of 6V lantern batteries in series, lasted the entire operation and showed no signs of failing. Some comments from stations worked:

W8KIT: 'Congrats on that signal with real QRP'
WØOPK: 'Unbelievable'
W5IUW: 'Ur really busting my ears'
W3KR: 'Boy, ur 5 watts FB here on my attic antenna'
W4KC: 'Did you say 5 watts?'
W2GA: 'Boy, ur rig doing FB'
W4YWX: 'Unbelievable — if I didn't know you I'd swear you're pulling my leg because ur hitting 20 DB'
K3CUI: 'Are you really running only 5 watts? FB'
OK1AOR: 'Sigs 589 FB'
K6IC: 'Your 5 watts sure good here'
UK2KAF: (ex UP2KNP): 'Ur low power sure doing FB'
K4ZA: 'Ur sig has real punch'

I did other hamming, making some 400 contacts on the other bands, both CW and SSB using high power equipment. Could have made many more QSOs in the same time using the high power rig but it wouldn't have been half the fun."





Power-Mite PM 3

PM 3: 20-40 meter bands CW only — power input 5 watts power required 12 V d.c. — 500 ma. High impedance output for headphones. **$69.95**

Power-Mite PM 3A

PM3 A: Same features except with break-in keying. **$79.95**

Order today from your distributor, or direct:

Please ship my ☐ PM 3 $69.95 prepaid at once.
☐ PM 3A $79.95

I enclose my ☐ Personal check ☐ Money order in full

Satisfaction guaranteed or money back.

Name_____

Address_____

City_____ State_____ Zip_____

Dept. M
TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862

Robert A. Hirschfeld W6DNS
Section Head, Communication Microcircuits
National Semiconductor Corp.
Santa Clara CA

UNDERSTANDING AND USING INTEGRATED CIRCUITS

The transistor was born amid predictions that vacuum tubes would soon disappear; then, some ten years ago, the first integrated circuits led to speculation that both tubes and transistors would be replaced. While neither of these predictions has yet been completely fulfilled, the last few years have seen substantial shifts towards exclusive use of ICs. It is becoming increasingly profitable for equipment manufacturers to substitute inexpensive, complex "subsystems" for the array of components formerly used, eliminating at the same time much of the assembly work.

For amateur radio, particularly the "homebrew" man, the wide availability of cheap ICs opens up new possibilities. Commercially built ham equipment should simultaneously improve in performance and decrease in cost. As spectrum space becomes more precious, and more sophisticated modulation methods become necessary, ICs will allow uncomplicated design and construction of transmitters and receivers which would have once caused casual weekend experimenters to give up in despair.

What Is an Integrated Circuit?

There's no reason to be mystified. An IC is simply a garden variety transistor circuit, in which a number of transistors,

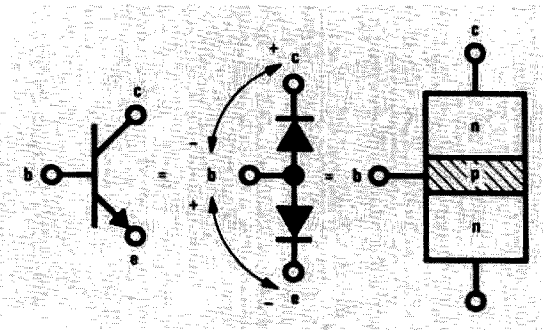


Fig. 1. An NPN transistor as two back-to-back diodes.

diodes and resistors have been made at the same time, by photographically and chemically treating a piece of the base transistor material – silicon. The IC, or microcircuit, is a natural outgrowth of the process used to make single transistors, so let's use the transistor as an IC primer. In its simplest definition, the NPN transistor

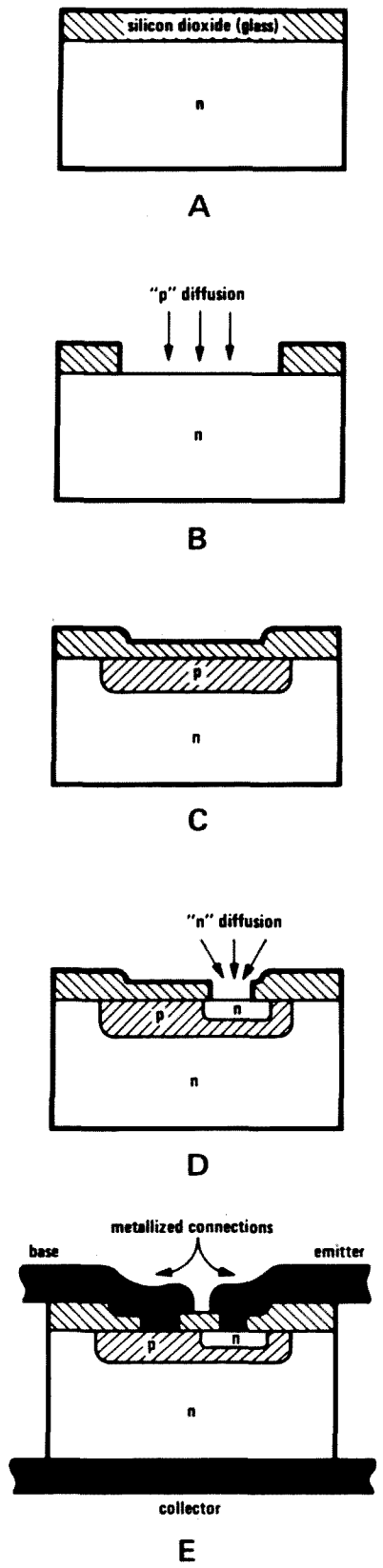


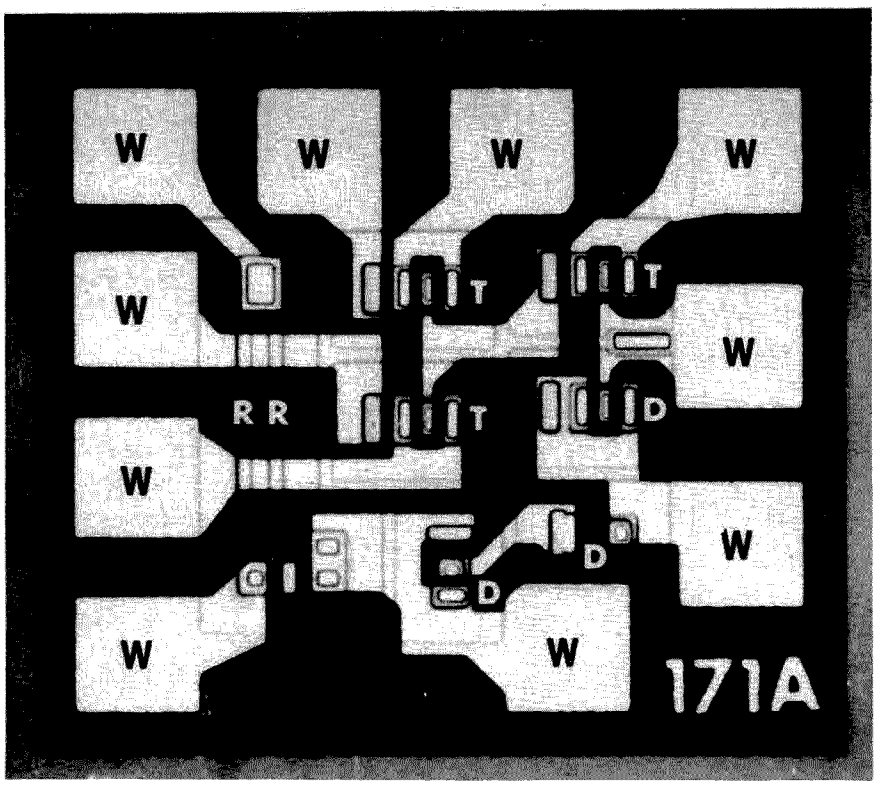
Fig. 2. Construction of a silicon NPN transistor (cross-section view).

of Fig. 1 consists of a forward-biased diode (emitter–base junction), and a reverse-biased diode (collector–base junction), which can be made from a slab of silicon by "diffusing" P- or N-type chemicals, in a high-temperature furnace, into selected regions of the slab.

Assuming that we start with a slab already containing N-type chemicals, Fig. 2A, and chemically "grow" a thin layer of glass (silicon dioxide) on top, the glass layer is now a shield against penetration of the slab by other chemicals. Using the same kind of photo-etchihg techniques used in the making of newspaper type and photo plates, we make a "window" in the protective glass, Fig. 2B, and then place the slab in a furnace containing P-type chemical gases. The result is Fig. 2C, a "diffused" region under the window in which the majority of atoms are now P-type, plus a regrown layer of glass over the window. A second window, smaller than the first, is opened, and the process is repeated in an N-type furnace, giving the structure of Fig. 2D. Windows are then opened, and contacted by a thin layer of aluminum, for each of the three regions in the slab, Fig. 2E. Attached to wires, and brought outside a can enclosing the slab, these three regions become the collector, base, and emitter. We now have an NPN transistor!

Why make just one transistor? Why not use a photo-etching process that makes many transistors, side by side, on the same slab? This is in fact how most single transistors are made today. Starting with one N-type collector region, many bases and emitters are diffused, with the resultant thousands of transistors, being cut apart afterwards and put in individual packages.

Suppose we want to build other components – for example, a resistor – using the same processing steps employed in making transistors. Why not use the built-in resistivity of the chemically treated silicon as a resistor? And why not cut apart the transistors in interconnected groups, rather than into individual pieces? One problem exists: isolating one element from another. Remember, in a slab, or "wafer," of NPN transistors, all collectors are in one



This photomicrograph of an IC rf amplifier shows NPN transistor elements (T), diodes (D), resistors (R) and the wire bonding pads (W).

region, and are thus shorted together. The solution is a fourth, P-type region, separating each transistor or resistor region (Fig. 3). If we bias this "isolating" region so that it always forms a reverse-biased P-N junction with everything it surrounds, each "component" in the IC will be effectively isolated by a nonconducting, open diode. We can now form any combination of transistors, resistors, and diodes we like, simply by choosing which "windows" we open at each step in the fabrication process.

What Are the Advantages of ICs?

Economy – Since we must go through the photochemical process to make transistors anyway, it costs very little more to make several of them; putting many transistors in one package is more economical than separating them. In the long run, an IC gives a lower "cost per transistor" than a discrete transistor circuit.

Ease of Use – Most of the signal processing and dc biasing is done within the microcircuit, so less wiring is needed to bring signals in and out of individual

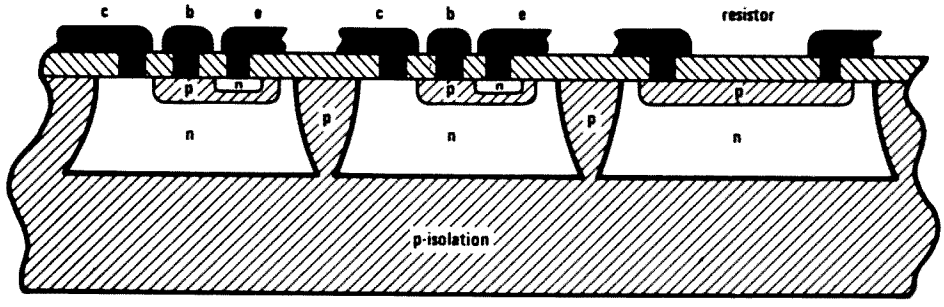


Fig. 3. Cross-section view of an IC, showing two NPN transistors and a resistor.

uses the NPN collector region as base, with P-type emitter and collector formed by two adjacent diffused-base regions. Current flows sideways, or laterally, from emitter to collector. Since the width of the base

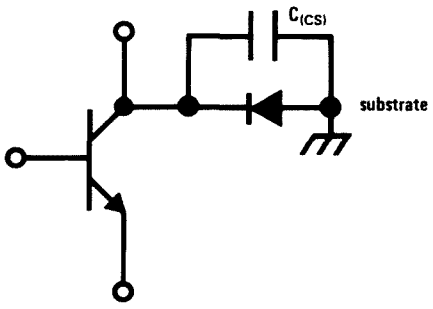


Fig. 6. The "Parasitic" collector-substrate diode.

region is much wider than used for an NPN, the lateral PNP has poor frequency response and a low beta. Thus, lateral PNPs are not used as gain stages, but only as dc level shifters, where necessary. The substrate PNP uses the same type of emitter and base as the lateral; however, its collector is the P-type isolation region, or substrate, which limits the usefulness of this transistor, since its collector is always grounded, and its characteristics as poor as those of the lateral PNP.

Medium-power NPN transistors are now practical; they take up a great deal of chip area because of the need to spread their dissipation over a larger region. Their collector saturation resistance is not as good as very inexpensive "discrete" power transistors, because IC collector contacts are necessarily made from above, while ordinary power transistors, which don't have isolation regions, have bottom collector contacts, with a shorter current path, and hence lower resistance. For most practical designs, an IC can handle power outputs to a watt or so, but must drive an external power transistor to obtain power levels. This also keeps IC power dissipation within the limitations of its small package.

Parasitics – Here is where the actual characteristics of an IC depart in unexpected ways from those of the same circuit in discrete form. The culprit is the P-type isolation region, which separates the various IC elements; it is a reverse-biased PN junction (Fig. 6), which is assumed to be an open circuit. But such a junction produces a parasitic shunt capacitance from NPN collector to ground, which can deteriorate high-frequency performance of the IC. While IC schematics rarely show this PN junction, it must be remembered by the user who applies supply voltage other than those recommended; since the substrate is commonly connected to the most negative point in the circuit, normal operation does indeed keep it reverse-biased, but an attempt to operate an NPN collector more negative than this voltage will forward-bias the junction, drawing possibly destructive currents. Finally, this seldom-mentioned junction can produce undesired substrate PNP action, or even act as an SCR.

Recalling that one definition of a transistor is that it contains a forward-biased and a reverse-biased junction, it can be seen that if the collector–base junction of the NPN is inadvertently forward-biased, it will form the base–emitter junction of a substrate PNP whether we like it or not. Moreover, this condition produces exactly the same trigger condition in the four-layer *NPNP* IC structure as is used to turn on a four-layer SCR. Under some circumstances, this produces "latchup," which holds until the supply is turned off, or draws enough current to damage the IC. In properly designed ICs, used according to manufacturers' recommendations, parasitic problems will not arise. Experimenters, using nonstandard external hookups, however, may find "parasitics" the explanation for the IC's unexpected behavior.

Conclusion

We've peered inside the marvelous, widely acclaimed IC, and found it to be a logical extension of known circuit designs and transistor fabrication techniques. It has a few peculiarities, but offers convenience, performance, and economy in building all types of ham equipment. A basic understanding of what goes into an IC, its advantages and inherent limitations, will prepare us to look at available ICs, and learn how to put them to work.

. . . W6DNS ■

transistor stages, or to interconnect bias voltages.

Performance – As we've seen, there's nothing magic about the individual transistors used in an IC; if anything, they may not be quite as good at high frequencies as their discrete counterparts, because of the capacitance to the "isolation" region. Their real advantage in performance is that we are no longer limited to designing circuits to use a minimum number of expensive transistors; we can design a better circuit that uses four or five times as many transistors, at less total cost than the discrete circuit. Moreover, interstage coupling and capacitance is much less of a problem than with "discretes," because of the microscopic lead lengths between components. Finally, because all parts of the IC are made simultaneously, by accurate photographic techniques, excellent component matching is guaranteed. For this reason, integrated circuits are available which simply are impractical using single, hand-matched transistors and resistors.

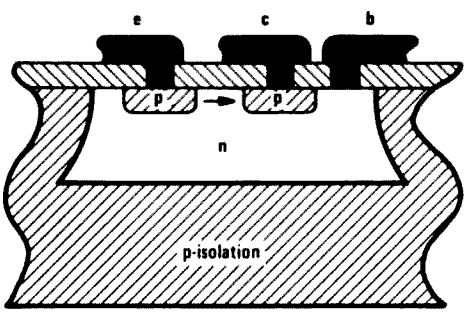


Fig. 4. Lateral PNP (cross section).

What Are the IC's Limitations?

Large Component Tolerances – manufacturers, despite their most careful controls, cannot prevent a wider variation in resistance, transistor beta, etc., than would be allowed in conventional circuits. A 1 kΩ resistor might well be 750 kΩ on units from a given production run, and as high as 1.25 kΩ on the same type of device from a different run. This was considered a problem in the early days of ICs, but designers soon discovered circuit techniques which overcame uncontrolled tolerances. While *value* of monolithic elements varies from run to run, the *ratio* of adjacent components is very accurately controlled. For this reason, most ICs are designed to rely mainly on ratios, rather than component values.

Limited Types of Components – Since the basis for the IC process is the same as that used for NPN silicon transistors, we might expect NPNs to be the best components resulting from that process. Adding resistors, diodes (which are really transistor base–emitter junctions), and zener diodes (which are reverse-biased base–emitter junctions), there is a much more limited selection of practical components available to the IC designer than with conventional circuits. Capacitors of any reasonable value take up too much chip space, which increases the IC's cost. A 0.01 μF capacitor, made either by using the capacitance of a large, reverse-biased PN junction, or by using the "glass" layer as a dielectric, with a metalized top plate would be several times larger than the largest ICs commercially made today. Thus, when a capacitor is needed for an IC, it must be placed external to the IC itself. In an attempt to minimize the number of external capacitors, many new ICs depart from the usual RC-coupled interstages, and are instead completely direct-coupled.

Similarly, inductance on a chip is impractical, so that ICs designed for tuned amplification generally require external tuned circuits.

While PNP transistors are used, they are not capable of nearly as good performance as NPNs, since the chemical processing is not optimized for them. Two types of PNP are available: the *lateral* PNP (Fig. 4) and the *substrate* PNP (Fig. 5). The lateral PNP

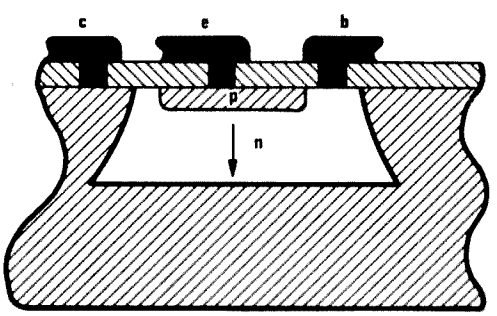
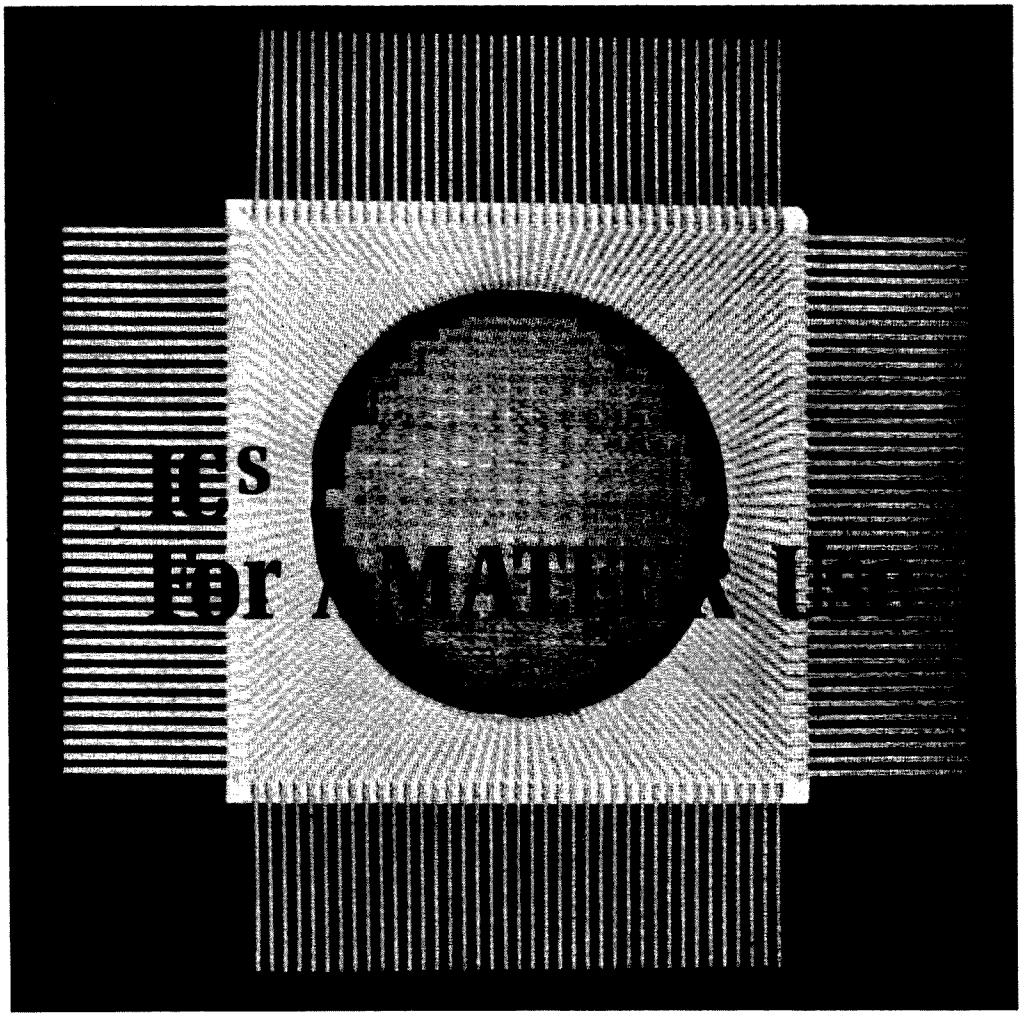


Fig. 5. Substrate PNP (cross section).



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Peterborough, N.H.

You may not like parts of this article, but then a lot of real life isn't all that likable either. I'm just going to put down my viewpoint of ICs as related to amateur use at the present time as I find them. Some can be very useful, and some are not so useful, even though they work well for their original purpose.

I hope this article will help you decide which kind to experiment with, and how to tell the useful ones from the kind that are good for computers only.

Integrated circuits are simply very small transistors, diodes, and resistors, constructed on tiny dice, sometimes called chips, of substrate material.

Capacitors and inductors are not generally included in these devices; therefore, in communications systems the external components are often many times larger than the IC itself. The benefits of ICs can be considerable, however, as in an example such as the HEP 590, which has high gain, low internal feedback, and absence of detuning effect over the entire avc range.

Computer ICs

This is where the whole thing started, and it was a fascinating story, for the science of electronics at least. In a computer there is a tremendous need for hundreds, thousands, and millions of memory cells, switches, gates, adders, shift registers, "scratch" pads, inverters, counter–dividers, delay lines, digital-to-analog converters, analog-to-digital converters, flip-flops, buffers, comparators, parity generators, current drivers, differential and operational amplifiers, binary

decoders, and a host of other device types – all of which are geared not for the ham but for the computer specialist.

In spite of the cumbersome logic that early Scientific American articles declared to be about ready to topple from sheer unreality, some computers *can* do things that cannot be done by men, such as computing an astronaut's course correction in a few seconds, solving vast and complex urgent equations also in seconds, etc.

But what concerns us as amateur–experimenters building new amateur communications equipment is the IC itself. Today's computers use, as one example, a 14-pin flatpack about ¼ in. long by about 1/8 in. wide, and *very* thin. The particular one I have in mind contains some 32 transistors and is the great-grandchild of a two-transisor flip-flop multivibrator, which can "stand on one leg or the other but not on both." To make the pesky little thing foolproof, they included a variety of "constant-current transistors, lockup prevention transistors, phase reversers, (which reverse the "truth table"), and heaven knows what else.

I did detail all the functions in there at one time, a few years ago, and believe it or not the specs on this thing do include a truth table. They do work, even though there is not one capacitor in there. Everything is direct-coupled. With 5V at several hundred amps total on a computer power supply they're happy with IV in the off state and 4.5V in the on. They work fast, too, like being clocked (pulse driven) by 2,10, or 20 MHz oscillators, or even higher as each year goes by. Yes, this does mean exactly what you're wondering about 2,10, or 20 *million* pulses, or "clicks of the clock" per second.

So the computer can work fast – so fast even that they're now worrying about the time it takes for a signal to travel over printed ribbon connectors from one tray to another. Sound familiar? Like short leads at VHF and UHF?

MSI and LSI

Just another word to let you know that the big manufacturers are not content with just 30 transistors in an IC. No siree!

Medium-scale integration, or MSI, which is just a way station, puts a lot more than 30 devices – really invisible to the human eye now – in that little can.

Large-scale integration (LSI) really gets to be high-density. I have one with 156 leads and 774 announced functions on a single chip.

There are manufacturers who make ICs that amateurs can use, as well as some transistors for TV front ends that look great for VHF and UHF.

Adding another transistor to the design of a chip is a matter of around 3¢ or 4¢, maybe even less today. You draw up a set of masks and reduce them down photographically to where each individual transistor-to-be cannot be seen at all except with a good microscope.

Then these masks are used one after the other to diffuse various materials going onto the chip, such as properly doped silicon, aluminum, gold, etc. – and eventually you have a wafer with fifty or a hundred, or some other larger number of ICs on it. One transistor more or less is thus only a matter of dividing the time involved in drawing it once – plus the engineering time of thinking about how to do it, and how to test it afterwards. This is one of the main reasons for the seemingly large numbers of active devices in some ICs. If there's any possible advantage, in they go! Why not?

Communication ICs

Here is a different story right away. Practically every "radio set" for communication work that I've ever seen or heard of has coils in it (or at least resonators if you go to UHF and microwaves). Now in a little flatpack only a few mils high how are you going to put in any tuned circuits? The answer is, of course, you don't. They go outside. So now where are you? You're up against a conflicting set of requirements.

There are some "natural" divisions of rf, af, and i-f circuitry where attention must be paid to the proximity of the components, as illustrated in Fig. 1. Shielding, or great care, or both, should be used at these points. They are;

1. Rf amplifier input–output.

2. I-f input–output, in particular from the diode region back to the front end –

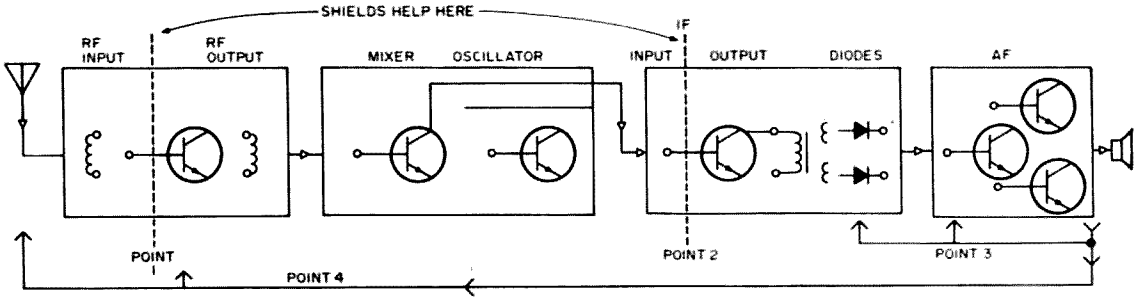


Fig. 1. Block diagram of typical receiver showing "trouble spots."

particularly touchy on certain i-f harmonics.

3. Af input–output.

4. Overall feedback from the af output to the front end, even speaker to antenna, this being often just a loopstick and close by.

In the following rf–i-f IC example you will see that certain things *can* be done on those tiny chips which are very interesting – not only for i-f work but for rf also.

Motorola's **HEP 590**

Motorola has a very interesting IC device for high frequency amplification, the HEP 590. Two outstanding advantages can be noted: low internal feedback, even when using the maximum gain of over 30 dB, and large avc action without detuning of the circuits

It is packaged in a 10-pin can some 5/16 in. in diameter. The leads can be soldered or inserted in a socket. The present suggested net price is $3.99, which is quite low considering what it accomplishes.

How the HEP 590 Works

Figure 2 shows the internal schematic. When avc voltage is applied to the base of Q2, Q3 is turned off and the ac gain will be at a minimum. This action takes place *without* noticeable change in the operating point of Q1, whose input impedance remains constant, with very little detuning effect on the input tuned circuit even with maximum avc voltage on Q2.

The configuration of Q1 and Q3 reduces the internal feedback to a low figure, which is generally immeasurable up to several hundred megahertz. With the 30 dB of gain obtainable at 60 MHz, this is a great advantage.

Diode D1 is for dc biasing of Q1, under conditions of varying temperature. Being laid out on the same silicon die as Q1, their currents will be closely similar, even with severe changes in temperature, with consequent dc stability.

The noise figure of a two-transistor pair is lowest when the input device uses the common-emitter connection. The second device will then have little effect on the noise figure.

The actual measured gain at 60 MHz is over 30 dB in suitable circuits, which consist of no more than tuned and impedance-matched inductors.

By the use of two of these devices in cascade, bandwidths of over 10 MHz may be obtained at 60 MHz, which shows considerable possibility for amateur microwave amplifier service.

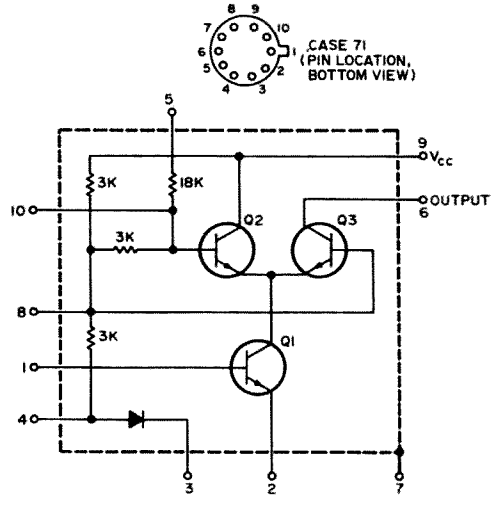


Fig. 2. Internal structure of Motorola's HEP 590 and pin identification data.

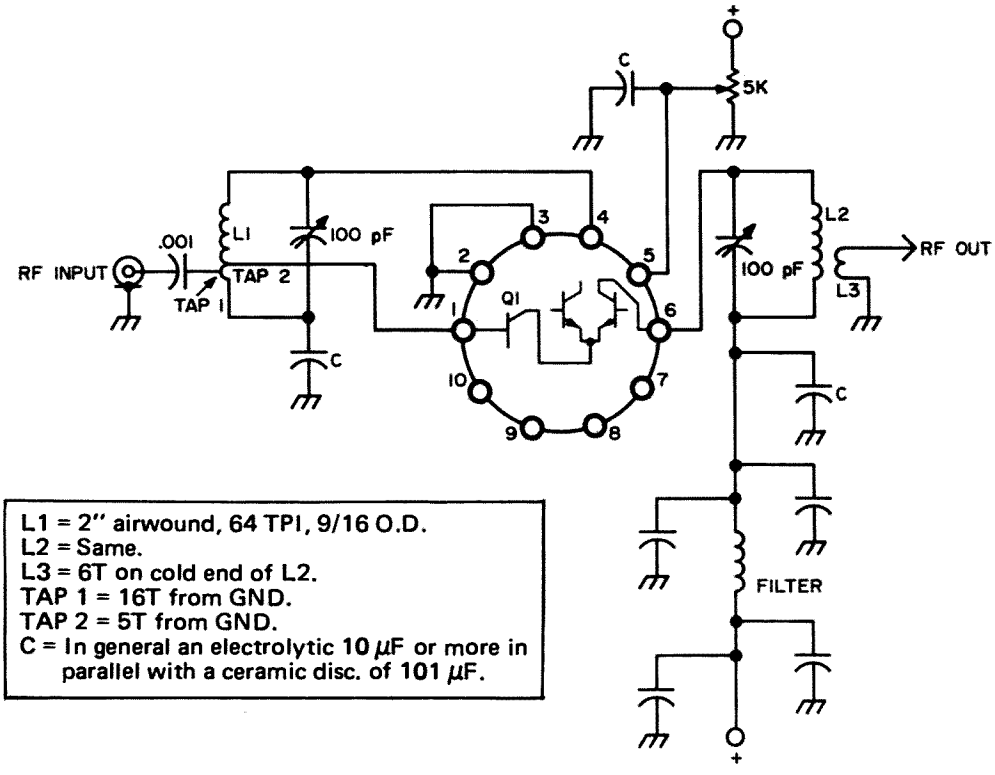


Fig. 3. 40m amplifier built around a HEP 590.

The **HEP 590** on the Breadboard

The 40 meter amplifier circuit of Fig. 3 was set up on a copper-clad baseboard with soldered connections to terminal strips. The antenna was brought in to a connection on L1 at 16 turns from the cold end and the 590 input lead (pin 1) tapped at 5 turns. The 100 pF capacitors (C1 and C2) are too large for in-band operating units but are all right for experimental use.

Manual control of the gain was accomplished with the 5 kΩ pot, avc tests to be done later in i-f service.

The output of the device (pin 6) was connected to the top of L2, and 6 turns of small wire wound around the cold end.

I started out with loose-coupled antenna, base input, and output link, but soon discovered this is *not* the way to go with the 590. It likes *lots* of coupling, on both input and output. When this was done, the really large gain of the device became evident. Various signals from 80 to below 40 meters sounded like reception with a superhet receiver (except for the selectivity).

When I used the device as an rf amplifier in front of my lab receiver, I had to reduce the gain of that receiver by a large amount. That **HEP 590** really has a lot of sock.

Putting the **HEP 590** on 6 Meters

After removing the 40 meter coil and putting in the required values for 6 meters, signals came in right away. Plenty of

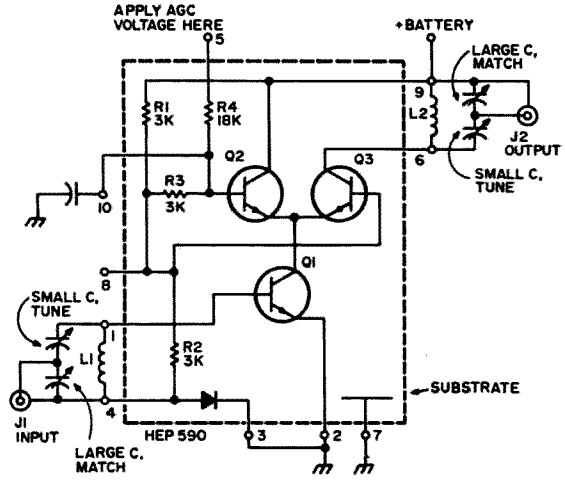


Fig. 4. 6M amplifier built around HEP 590.

stations were heard, and in particular, using a 100 ft wire, Q5 signals were heard that could not even be found on the dial without the 590 preamp. It works! The 6m values for the inductors are as follows: L1 – 4 turns at 8 turns per inch, 9/16 in. diameter; L2 – 5 turns at 4 per inch, 9/16 in. diameter L3 – 4 turns, wound on L2. Figure 4 shows the 6 meter version of the HEP 590 amplifier.

So the Motorola HEP 590 IC linear amplifier works as claimed. It is a relatively easy IC to practice on, with only three active devices inside, and can be built up into a circuit and tested in a day's time.

From working with it so far, I can verify that excellent reduced-size, high-frequency i-f amplifiers for amateurs can be made with it.

The Amperex TAA300

The home of Amperex being not too far away in Rhode Island, I visited down there for half a day and was well rewarded with some new VHF transistors that look swell, and also in meeting some topnotch engineers in the lab.

The TAA300 is a complete af amplifier in one of those little 10-pin cans, and puts out a watt of audio when required – enough to modulate a couple of watts of rf on 6, 2, or 432 – which, along with the exciter section, will take just about all of the dc power of two lantern batteries, rated at 12V and 0.5A.

And it's good for the receiver also. Plug the i-f diode output into it and there's your loudspeaker banging out a watt. Let's take a quick look at one of these.

With ICs, allow for lots of time. Some of this time will be spent in puzzling out three things: the internal circuit, the external circuit, and how to draw one schematic that has both.

I am counting on the TAA-300 to do a lot for use as a 1W af amplifier; but once again, remember that these little gems are not primarily made for experimenters – they're made to be wavesoldered into small radios and TVs by the hundred thousands.

An engineer in a large company can afford to sit down at his desk and spend a week or two figuring how to best put this

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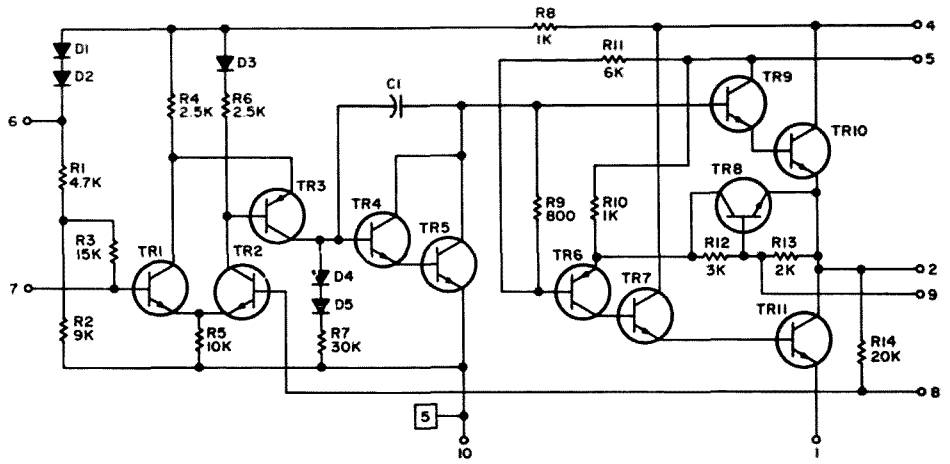


Fig. 5. Amperex TAA300 – a 1W audio amplifier IC.

device into a set because that week can be spread cost-wise over (hopefully) a large number of sets if he does a good job. Can you do this just for one item?

Does the circuit of Fig. 5 look like an audio amplifier? Where's the input and the output? What are those five diodes doing in there? Why 11 transistors just for an af amplifier when the "All-American Five" design will give you mixer, oscillator, i-f, af driver, and af power stage?

Don't think I'm running this thing down, because I intend to use it. I just want you to be prepared for a little "new thinking."

With printed circuitry it has always been my feeling that why should anyone build just one? To learn the printing process involved, yes. For building one circuit, no. Now some of these little 10-pin jobs *are* good for experimenters, and you may also be interested in learning about them for business reasons, too – or for size, although to really cut down in size calls for some pretty expensive external components. Look at Fig. 6, the external circuit. There is a .64 μF capacitor on pin 6, 400 μF from pin 2 to pin 5, a 25 μF capacitor on pin 8, and 47 μF from pin 2 to ground. With "ordinary" size electrolytics three of these values are each four times the size of the device itself, but I expect with voice frequencies some of these can be cut down a bit.

Then there are a few application notes to think about, like the stability question, and a few others, but they are not bad.

All worth-while things take time, and this is one of them. Be advised, and allow yourself time enough to study it out before you pick up that little soldering iron.

Amperex TAD100

Ambitious, knowledgeable, hardworking people have looked at the several-million-per-year market for just plain old radios (new ones, of course) and thought about making ICs for them. And they made some. I have worked with one of them, the Amperex TAD100, and here is the story as I found it.

There are a dozen or so transistors in the little plastic box only 3/4 in. long, as you can see in Fig. 7, the internal circuitry of this one. These transistors are pretty close together in there – much too close for an amateur experimental unit, as you will see.

The manufacturer, ambitious as he was, did produce large numbers of excellent and very tiny receivers with this IC. It has a mixer, oscillator, i-f, detector, and an af amplifier – but no power stages. Almost everything you might need, except you have to add a few things on the outside, of course, as shown in Fig. 8.

There are some good ideas incorporated into this baby – like using two transistors for the mixer. So are three for one i-f stage. I don't particularly go for the four transistors in the af stage, without even the power output unit yet, but it does work.

What doesn't go for the amateur experimenter is the fantastic proximity of the input, the mixer, the oscillator, the i-f and

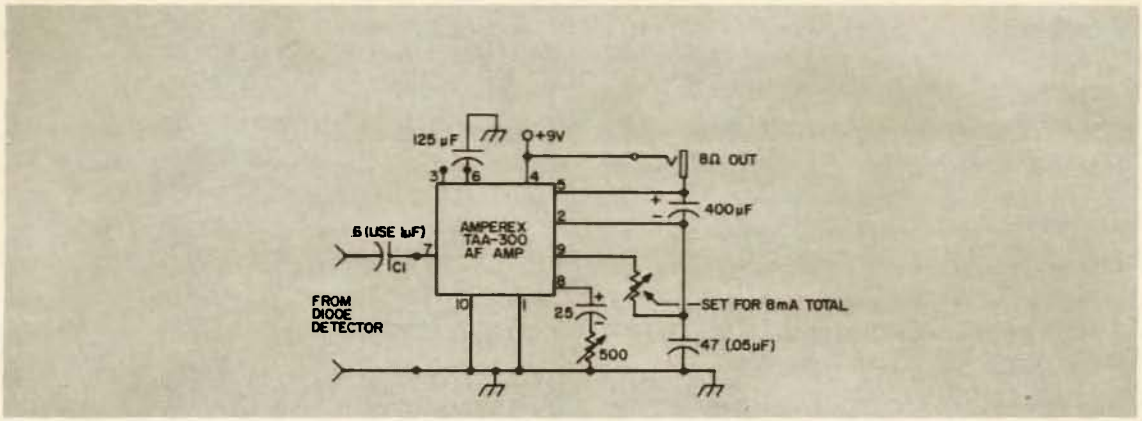


Fig. 6. External connections required to get the TAA300 operating as a complete amplifier.

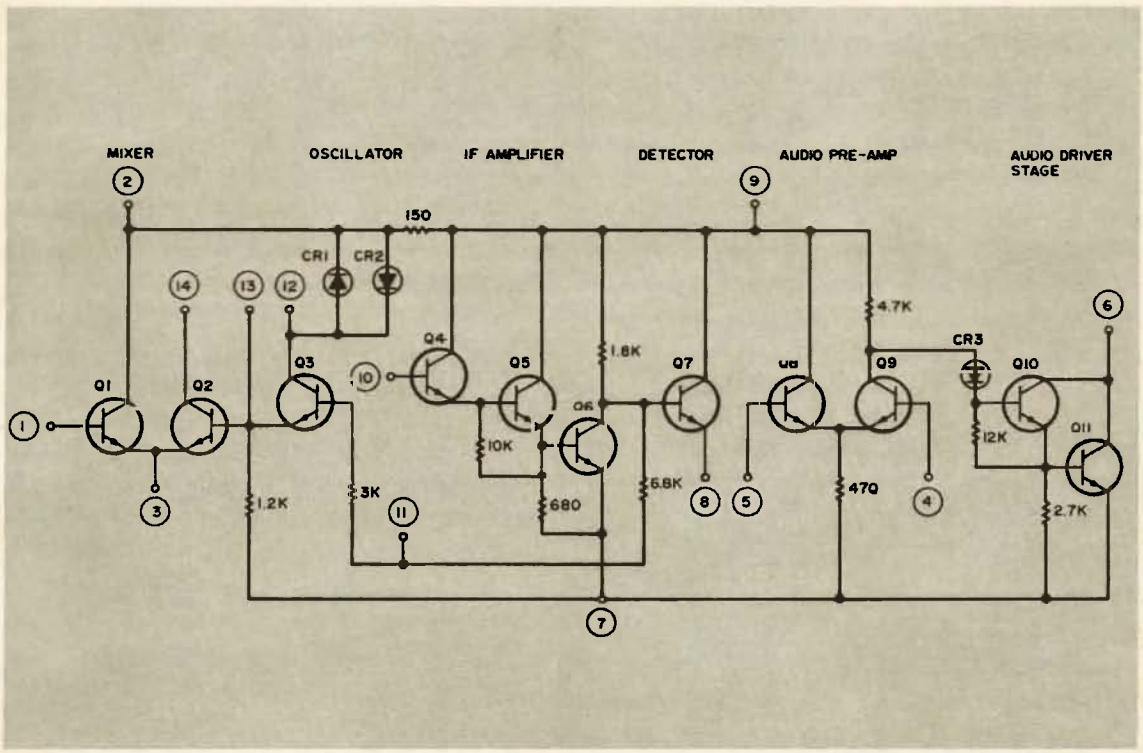


Fig. 7. Amperex TAD100 is a complete broadcast receiver in one tiny package.

the af – all in there together on that one tiny chip. Just too, too close for me. When everything is running right with all the precautions advised and an exact copy of the original printed board is made up and all the components are in exactly proper places, it does work as a BC set.

One of the precautions listed: "The oscillator must be limited to 100 mV; otherwise it will get into the i-f and the af." It did! I worked 10 days on this particular IC and to make a long story short, the mixer and the i-f ran okay at times (and at times not), but when the internal local oscillator was used, I kept running into trouble.

Bear in mind, such an IC does work fine for mass production of BC sets. It's just that for an amateur experimenter as a single unit, there is too much feedback involved. Also, the oscillator is strictly limited to the BC band service, which

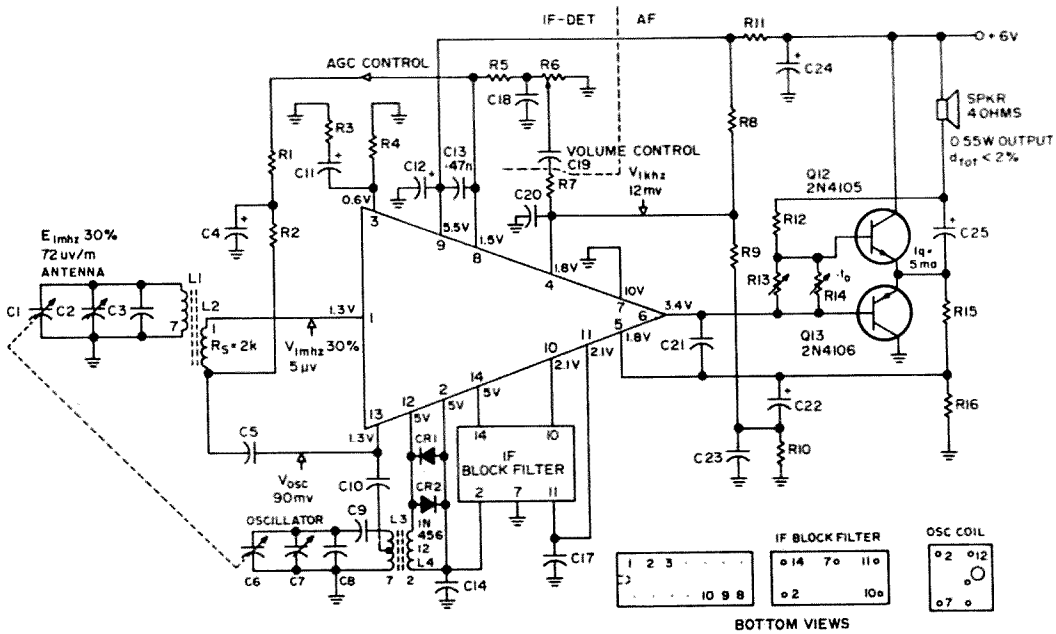


Fig. 8. External circuitry, B.C.—I.C.

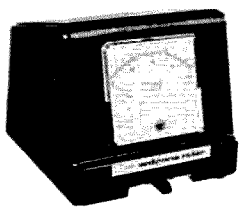
precludes using it as an amateur converter. The people handling this unit are excellent engineers and have some other *very* good devices; and they are still working with newer and better devices for a complete set (including an FM job!), so we will almost certainly see them again soon.

. . K1CLL■

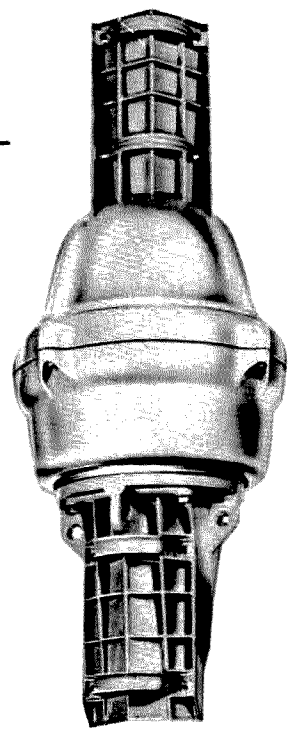
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(Cont. from page 10)

is irrelevant. I did notice that most of the fellows that managed to work through to me were interested in a New Hampshire contact or else wanted to just say that they enjoyed the magazine. No traffic for the news pages ever developed.

I'll try and get on around 14.210 or so at 2100 and 0200–0300 whenever I can. If you have news items please just mail them in and let's forget that General section of 20 meters.

News Pages

If you are involved or get word of anything that you think would be of value to the 73 newspages please take it upon yourself to act as a reporter and get the news in to us. The last minute for each month is the 20th.

The news pages not only are of considerable value to our regular readers, but we go to the trouble and expense each month of reprinting the first two pages and sending them to every congressman in Washington. Thus your news stories can do a great deal towards creating a favorable climate for our hobby in Washington.

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In addition to news which is of national or international interest we also would like to have news of activities on the various amateur bands . . . particularly interesting nets . . . unusual contacts . . . DX stations of note . . . VHF band openings . . . contest announcements . . . special awards . . . etc. These announcements won't warrant a press card and byline, but they will help to make amateur radio more fun for all of us.

Your Vote Counts

Half of the sixteen ARRL directors are up for reelection each year. When those of you who have not dropped out of the League cast your vote this fall you might keep in mind that little is to be gained from keeping the same old faces in office. A reading of the minutes of the last board meeting will tell you the story. . . most of them are sales reps coming to you from headquarters rather than your representatives running your club.

More Phone Bands?

The September issue of QST carries an article on why the ARRL directors decided against expanding the U.S. phone bands. The article is interesting, but completely out of touch with the realities of 1970, expressing the leftover concepts of twenty years ago.

The main theme is that if we expand our phone bands, phone operators in the rest of the world will move into the CW bands to get away from us. Back in the AM days this would have been so. It is unfortunate that so few directors and HQ personnel are active amateurs; otherwise, they would certainly have realized how completely out of date the arguments were.

Few DX contacts are made cross-band these days compared to the old AM days. Twenty years ago it was unusual to work a DX station operating inside the U.S. phone band. Today it is extremely unusual to work one outside our band, with the exception of a few DXpeditioners who have curious reasons of their own for split-frequency operating. There are times when it is better for a rare DX station to work split, but the need for this is unusual. There seems to be little need for a "DX" portion of the band today for phone.

While operating from JY1 I tried operating above and below 14200 and I found vastly more DX activity above 14200 than below. The lack of U.S. phone stations below 14200 has encouraged commercial occupation of these frequencies and few of them are free of this sort of interference, and thus few are of much use to anyone anywhere. If this band were opened to U.S. phones I believe that the periodic assaults of QRM from the U.S. would drive a great many of these interlopers to clearer channels, thus benefiting amateurs everywhere.

It is unfortunate that the ARRL directors are so inactive that they are not aware of conditions as they are in 1970 and thus were talked into completely giving up the weak try they made to get HQ to push for more phone frequencies.

If you think I am exaggerating or coloring this then please take the time to read the Walker article in QST and the board minutes. Ugh.

. . . Wayne ■

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PRACTICAL IC REGULATOR CIRCUITS FOR HAMS

Don Nelson WB2EGZ
9 Green Ridge Road
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The experimenter has broad horizons with the many low-cost ICs and semiconductors available today. While many of the ICs have been designed for a specific service, such as an audio amplifier or a logic switch, there are types which contain several transistors to be used in almost any application. The RCA CA3018 exemplifies the second category. Let's examine the device as an introduction to integrated circuitry.

Four silicon transistors are formed on a common monolithic substrate within the CA3018. Two of these transistors are interconnected by having the emitter of one tied to the base of the other. Either of these transistors may be used separately since an external lead connects to the emitter-base link. The intent of the interconnection is to use the transistors in a Darlington circuit. The other two transistors are isolated as shown in Fig. 1. Notice the substrate is important enough to have its own lead. In this IC, as in most others, there is diode action between the substrate and some elements of the circuit. You can see this characteristic using an ohmmeter between the collectors and the

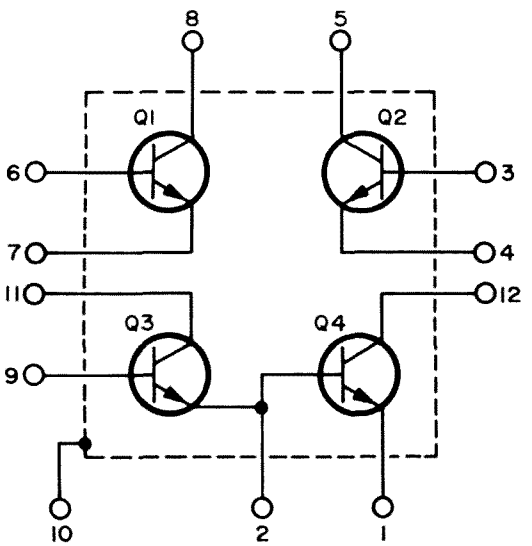


Fig. 1. Schematic diagram of RCA CA3018. Numbers refer to pins of IC.

substrate. These diodes are reverse-biased by connecting the substrate to the most negative point in the circuit, thus isolating the transistors. If the substrate is not connected in such a fashion, you may not get transistor action from the circuit.

The transistors in the CA3018 are useful from dc to 120 MHz. One of the big advantages of integrated circuitry is the matched characteristics of the transistors within. Gain, for example, is matched better than 10% and the base–emitter voltage match is better than 2 mV over a wide temperature range. Because of these characteristics, this and other integrated circuits are excellent for temperature-compensated circuitry.

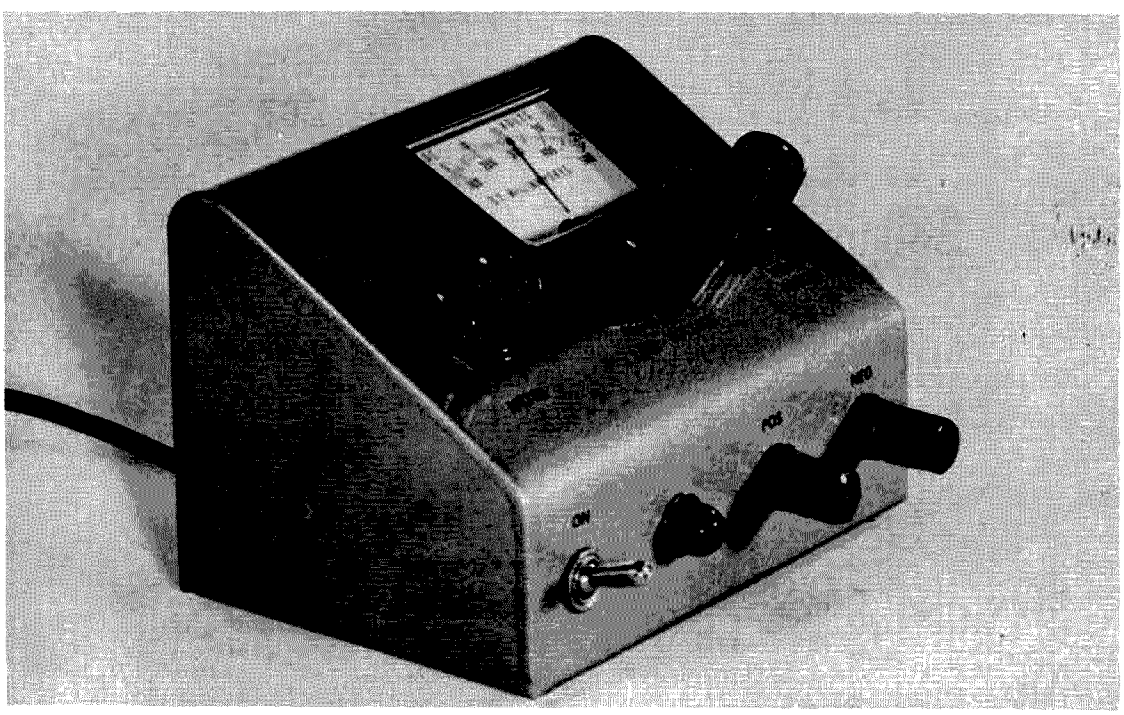
Another plus for most ICs is the excellent low-frequency noise figure. Transistors in the CA3018 array boast 3.2 dB of noise at 1 kHz. At 100 MHz, the noise figure is typically 7 dB, so this device is favored for operation below VHF.

Learning to use the best characteristics of a device and learning to design around its limitations are good engineering practices. I once heard a ham brag, "The 4X150 is a great little tube – mine is dripping solder from the radiator, but my power output hasn't dropped." Well, those good old days are gone when you use semiconductors – so learn what the ratings are all about. Maximum and minimum values for the CA3018, which must be observed, are listed in Table I.

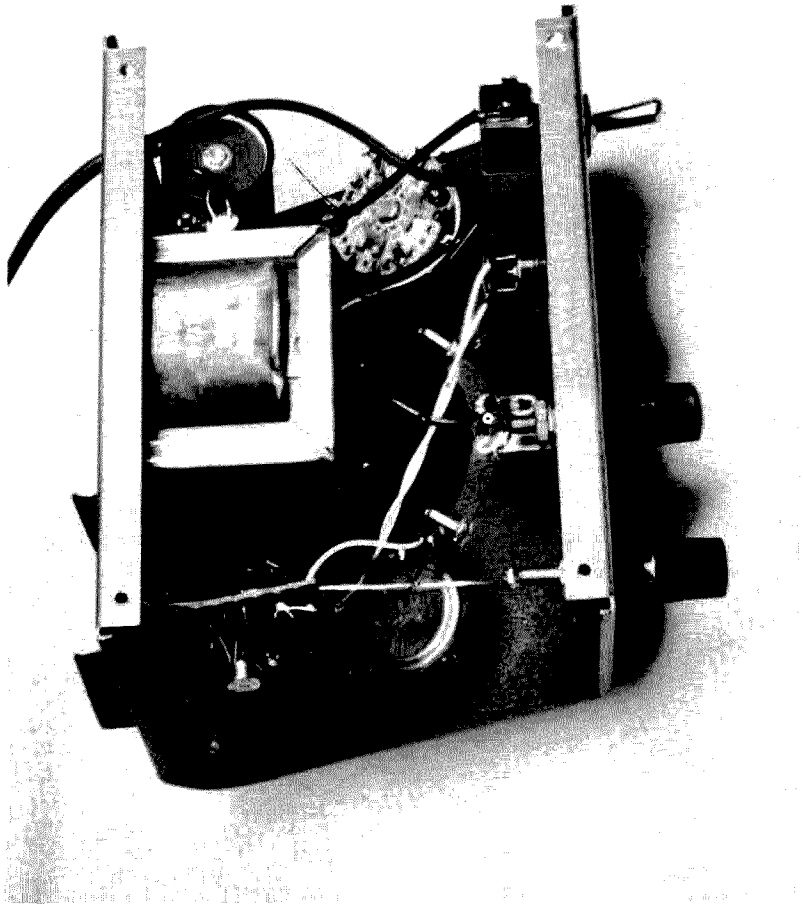
Table I. IC Parametric Limitations at 77°F.

Parameter	CA3018	CA3018A
Maximum power dissipation:		
any single transistor	300 mW	300 mW
total package	450 mW	450 mW
Derate 5 mW/°C for TA >85°C		
Maximum collector-to-emitter voltage	15V	15V
Maximum collector-to-base voltage	20V	30V
Maximum collector-to-substrate voltage	20V	40V
Maximum emitter-to-base voltage	5V	5V
Maximum collector current	50 mA	50 mA

Those readers who are familiar with transistors will find only two new ratings; a total-package power rating, and a collector-to-substrate voltage rating. The first is a limit for the sum of the power dissipation of the individual transistors. For example, if one transistor operates at the 300 mW level, the average power of the remaining



Exterior view of the 500 mA power supply. The case used is a Bud CMA 1930.



Placement of parts is only critical with respect to squeezing everything into the box. The 2N5295 transistor is outside the rear apron and insulated from the main chassis. A piece of copper 2-1/2 x 2 x 1/32 in. forms a heat-sink for the power transistor.

three may not exceed 50 mW each (300 + 3 x 50 = 450). The second new rating refers to the breakdown voltage of the collector-to-substrate diodes. These diodes are always reverse-biased because the substrate has been connected to the most negative part of the circuit. It is easy to determine the exact voltage in a circuit because the collectors are frequently at the most positive voltage.

Many ICs have low breakdown voltage ratings, which can be a serious disadvantage. In some cases, you may be able to design around the problem. Another problem at the experimenter's level is the fact that if one transistor is destroyed, the whole IC has to be replaced. This disadvantage is somewhat offset by the low $1.62 cost of the CA3018, but it is hard to rationalize soldering 24 leads for each mishap. A discrete transistor could be used in a crisis with the CA3018. Better yet, use a socket for breadboarding.

Applications

The CA3018 is a natural choice for a power supply regulator amplifier. Such an application, I feel, is also interesting for analysis. In Fig. 2, I have drawn a very basic regulated power supply using three of the transistors. Let's examine its characteristics from the ratings of the IC.

Nearly all the current to a load will flow through Q4 (pins 12 and 1); therefore, we are limited to 50 mA, which is the maximum collector current of any single transistor. If you think about it, this is all the current required by many circuits. The power supply could service almost any circuit now operated on small 9V batteries. An FM portable receiver draws peaks of less than 20 mA; AM radios draw even less.

The second rating to consider is the collector-to-emitter voltage. The greatest permissible value is 10.5V, which is well under the 15V rating of the transistor. The collector–base breakdown voltage is not

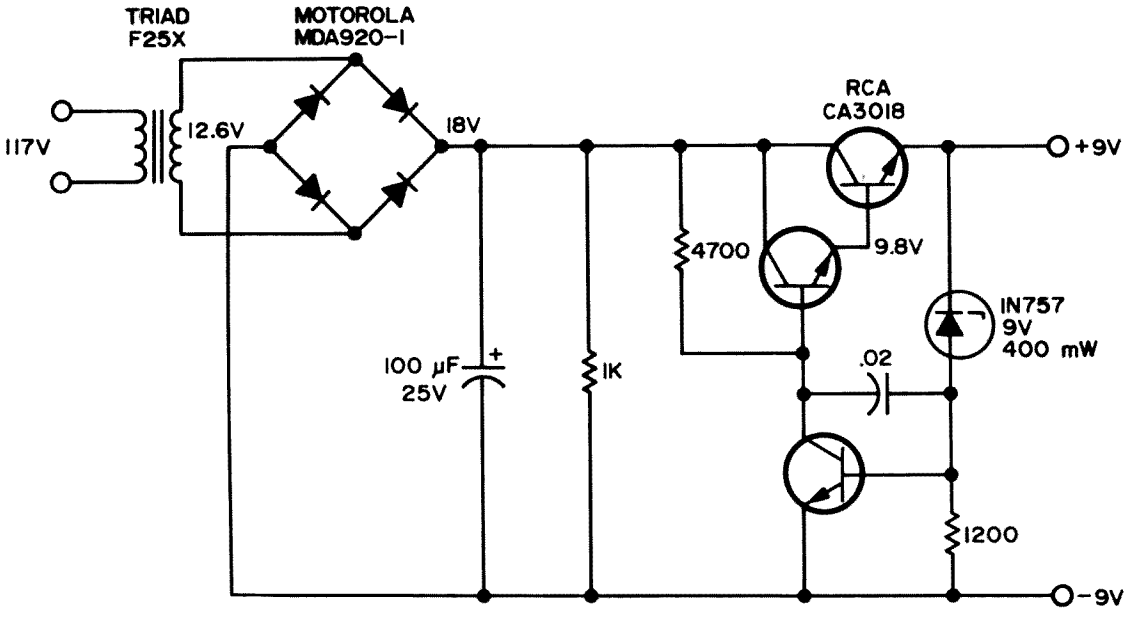


Fig. 2. Regulated 9V 30 mA power supply using CA3018.

exceeded and the emitter–base junction is never reversed-biased, so the design is clean in those respects. Don't forget the collector-to-substrate rating. In this case, the maximum voltage seen is 18V: okay for this circuit, but not for the next one.

When considering the power rating, it is safe to assume we will not exceed 85°C (no derating necessary), and the power dissipation of Q4 will be much greater than the total power of Q1 and Q3. At 50 mA of current, the power (P=IE) would be .050 (18–9)=0.450W, which is high for a single transistor. A reduction in output current or lowering the input voltage on pin 12 is necessary to operate within ratings. In any case, it would be wise to heatsink the IC for this circuit. You may expect it to get hot above 30 mA.

The shortcomings of the CA3018 become apparent as we attempt to design a more versatile supply such as the one in Fig. 3. A 2N5295 power transistor was added to the basic circuitry in order to

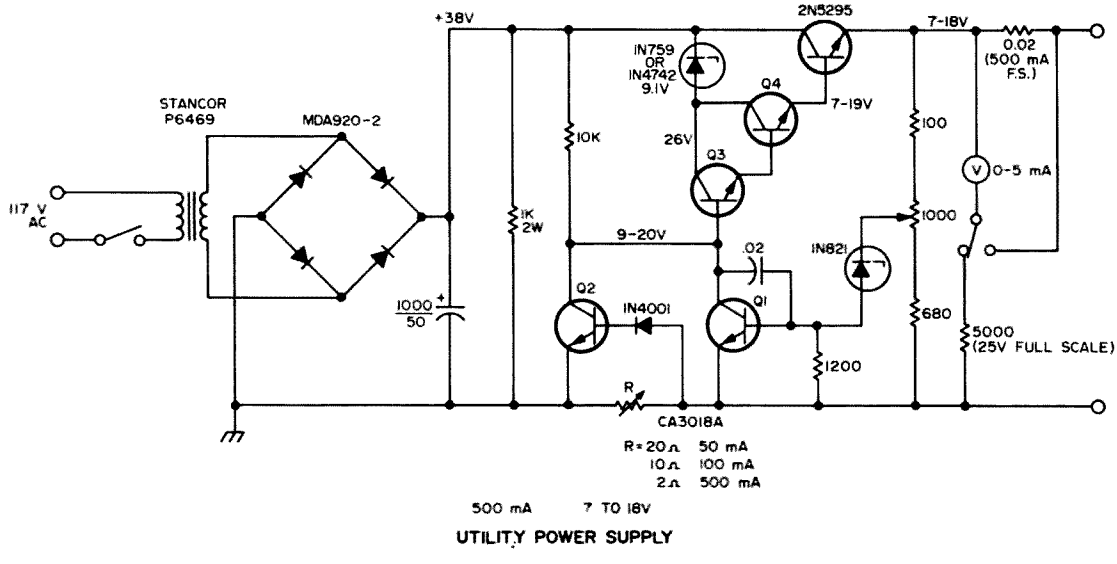
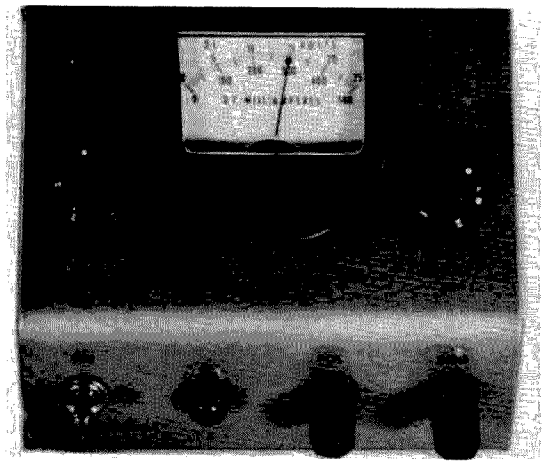


Fig. 3. "Utility" power supply with 7–18V output. Resistor R determined by current requirements: 20Ω–50 mA; 10Ω–100 mA; 2Ω–500 mA.



The completed 500 mA regulated low-voltage power supply.

operate to supply to 18V and 500 mA. Other changes include the use of a temperature-compensated zener diode, variable voltage output, and current limiting by use of the fourth transistor on the IC. Incidentally, you might just want to build a power supply like this if you are newly acquainted with semiconductors.

The 2N5295 will handle 500 mA and higher voltage with ease. If we assume the beta of that transistor is 50 at full load, the base drive required would be 500/50, or 10 mA. That is no problem for Q4 of the CA3018. On the other hand, it soon becomes apparent that we need higher than 20V breakkdown. Some relief is obtained by using the CA3018A, but not quite enough to handle the collector–emitter voltage drop across the Darlington pair. By using a zener diode between the high-voltage point and pins 11 and 12 of the IC, the collector-to-emitter voltage requirements are reduced, as is the collector-to-substrate voltage.

It is not necessary to use a temperature-compensated zener here. Collector-to-emitter voltages are the only ones above ratings now. Three CA3018s tested had collector-to-emitter breakdown voltage ratings in excess of 23V; however, this is a weak point in the design.

Power requirements are lower with the addition of the 2N5295. The maximum power through Q4 is 23V x 0.010A= 0.230W, enough less than the maximum rating that no heatsink is necessary.

A word about the operation of the current limiter is in order for any prospective builder. Transistor Q2 is normally turned off until an overload occurs. At this time, the voltage drop across **R** is enough to turn on the 1N4001 and the emitter–base junction of Q2. As the transistor is turned on, its collector is pulled toward ground, thus turning off Q3, Q4, and the 2N5295. As soon as the overload is removed, the supply recovers to its former voltage. This limiter may be made variable for limiting at lower currents. Approximate limiting values are shown in the schematic. Under extreme current limiting conditions, the collector-to-base voltage of Q3 and Q4 will approach 26V. This is acceptable for the CA3018A.

While the CA3018 is not truly a circuit, it provides an interesting introduction to the technology and characteristics of integrated circuitry. Its versatility invites experimentation. For those who would like to duplicate the regulated power supply shown in the photos, I include a full-size

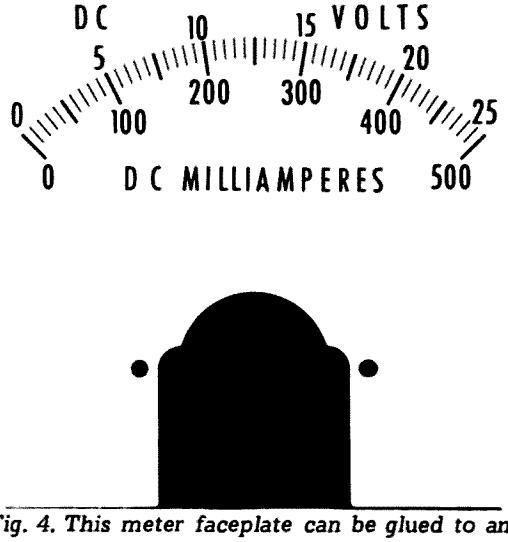


Fig. 4. This meter faceplate can be glued to any appropriate sized meter with a 5 mA full-scale rating.

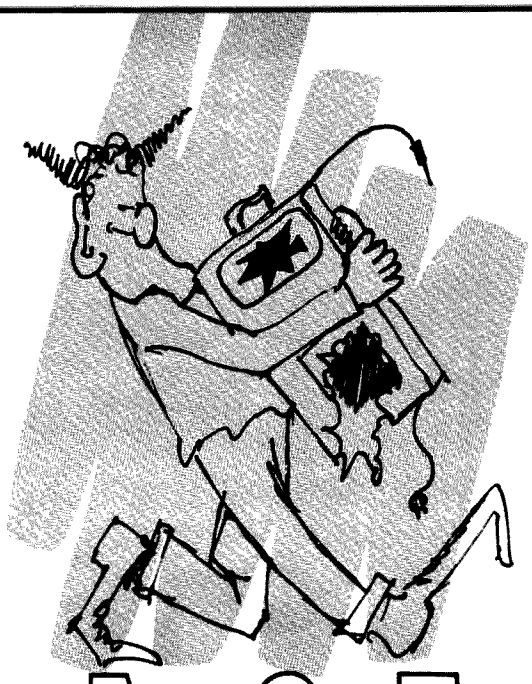
copy of my meter panel as Fig. 4. This can be copies or cut from the magazine and glued to the face of an appropriate 0–5 mA meter.

Reference:

Several other interesting circuits for the CA3018 are discussed in the RCA integrated circuits manual, where complete ratings and typical characteristics are listed.

. . .WB2EGZ ■

Guy Slaughter K9AZG
753 W. Elizabeth Drive
Crown Point IN



CAMOUFLAGE

Most *73* articles tell, but this one asks. The usual how-to piece gives counsel from one ham to many on what need be done to solve a stated problem, but this one reverses the process.

Because a quarter-million heads are better than one, advice is sought from the collective conscience of hamdom for the immediate benefit of one amateur – namely me.

In exchange for such desperately needed aid, I am prepared to provide similar-type advice in the same field acquired the hard way, through personal experience involving cut-and-try methods refined in the crucible of actual domestic confrontation.

Camouflage!

A recent proof of this pudding in my own background went this way:

Like this:

If you've bought a new piece of gear you're unable or unwilling to explain to your XYL, equipment costs being what they are and "holdout" money piling up in your wallet's secret compartment the way it does, here's the formula to follow:

Stopping off at a hardware store on my way home from Happy Harry's Ham Headquarters with a shiny new Drake R-4A under my arm in its shipping box, I bought the things a fellow needs under such circumstances.

The clerk said, pointing to my burden, "What ya got in the carton there, Charlie?"

Knowing him to be a big-mouth type who sometimes waits on my wife, I told him, "Frabbersnatches for my flibbergist, and the danged things leak. You got transparent masking tape and some window putty?"

He did have, so I bought some, added a can of red Rustoleum, and retired to my private – if shabby – office.

After sending my secretary (a nosy type who thinks more of my wife than she does of me) across town to get a signature on an obsolete deed from a guy I knew to be vacationing in Guatamala, I went to work.

Inside my sanctorum with the doors locked and my phone off the hook, I taped, painted and puttied.

In half an hour the new Drake looked like a World War II field telephone junction box nine years out in the rain. Switching the shiny black knobs for some assorted beat-up brown and gray ones I keep in my desk for just such purposes completed the transition.

I then carefully shredded the new shipping carton and the bill of sale into little pieces, flushed them down the office dooley, and stuck the Drake into a battered cardboard box the janitor used for

his supplies.

Then I went home with it.

The XYL met me at the door, where I avoided her glassy eye by staring at her messy hairdo. "Been to the beauty shop today, Honey?" I asked in hearty greeting.

She mumbled something unintelligible, turned up her nose at the Drake, and uttered those welcome words.

"I wish you'd quit hauling that junk home to fix for your rotten friends," quoth she.

See how easy it is?

Of course, after a few weeks the paint-streak rust spots and the putty scars can be wiped off the gear, a little at a time, the protecting tape stripped away, and the original knobs replaced one by one.

If the transitional work is done gradually, your resident enemy won't notice that the beat-up box has been transformed into a thing of beauty.

On the other hand, if she or the spies she has mothered are the observant type, you can leave the camouflage in place until you're ready to trade it off for a new goody.

Either way, scarred up or cleaned off, the receiver's utility as a signal-catcher won't be affected by its exterior appearance, though your well-being may be.

In the same way, I've quietly acquired through the camouflage system a 24-hour digital readout station clock, swr bridge, coax switch, electronic bug, VTVM, scope, mobile rig, and beam rotator, all on hold-out money and all without attracting my wife's attention.

I recommend the system unequivocally.

But now comes the problem, and here's where I need help and advice.

So far, my camouflage activities have been relatively minor-league, not really preparing me for the major-league ordeal ahead, the crucial crisis that separates the men from the boys.

Please, you out there, rescue me with some counsel: How do I smuggle up in my back yard (without the XYL noticing it) the new 50 ft mast and tribander hidden in the basement of my office building?

. . . K9AZG ■

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THE PHASE-LOCKED LOOP COMES OF AGE

It's been a little more than 13 years now since the idea of "synchronous detection" entered the ham radio world – and the odds are, unless you're a dedicated VHF and DSB (yes, we said *D*SB) nut like I am, you still haven't heard very much about it.

Not that some of us haven't done our part. The initial publication of an article of the subject back in 1957 (three years before *73's* birth) was accomplished under Wayne Green's guiding hand in CQ Magazine, and the next synchronous-detection bombshell (conservatively titled *50 dB Under the Noise – A Breakthrough*) saw the light of day in the short-lived pages of 6-Up, *73*'s subsidiary VHF magazine of the mid-60s.

But all the way through, the synchronous detection idea has had a tough obstacle to battle: While it does give all the performance claimed for it, it requires several times as many components as does a conventional detection circuit. The 1957 version used eight double-section tubes to give 16 stages; the 1964 edition (actually a completely separate implementation of the same basic idea but giving other features) was solid-state and required 24 transistors.

Quite obviously, this is a larger stage count than that of many complete receiver designs. So long as so many devices were necessary, the synchronous-detection idea just couldn't make it in the face of its much simpler competition.

But all that was changed in the last year when a major manufacturer of integrated circuits put together a single-chip circuit which does just about everything required for the synchronous detector, in a single standard-sized 16-lead dual-inline IC package. Although it contains approximately 50 transistors, the whole thing takes only

about 10 mA from an 18V supply, and is hardly as large as a commemorative postage stamp.

And to top it off, the price of the device is surprisingly low, considering what you get. There are several different versions with different features, but the least costly of them is still a complete FM receiver which accepts a minimum 300 μV signal (across 3 kΩ) at any frequency from 100 Hz up to 60 MHz or so, with any deviation up to +20% of center frequency, and produces 60 mV of audio output across 8 kΩ. This one costs $30 in single-lot quantities, according to the most recent price list, but that's all you need for a complete receiver within its frequency range and sensitivity.

On top of this, remember that these are current prices, and the unit is not yet in wide use. If it catches on as it apparently should, the cost is bound to come down. Remember when the CK-722 transistor sold for $7.50 each? And now they're down to 4 for $1 from the mail-order houses?

What Is Synchronous Detection?

The words "synchronous detection" have been applied to many different detection schemes, but all of them share the idea of using a stable local oscillator to mix with the incoming signal, and developing an error signal should the local oscillator get off frequency. You might call it a sort of superhet receiver, with automatic frequency control and a zero-frequency i-f, if that brings any reasonable picture to mind.

The most common type of synchronous reception currently used (yes, it *is* being used – by radio astronomers, space communications systems, long-range radar, and any place else that the ultimate in radio communications is required, thus justifying the complexity and cost of the older approaches) involves a "phase-locked loop."

The phase-locked loop includes a phase detector, a low-pass filter, and a voltage-controlled oscillator. The phase detector is a circuit which accepts two different rf input signals, and produces a dc-to-audio output signal which reflects the phase differences between the two inputs. That

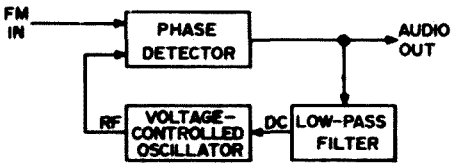


Fig. 1. Basic phase-locked loop or synchronous detection hookup for FM reception uses voltage-controlled oscillator in a servo loop. Output of VCO is continually compared with input signal in phase detector, which produces an output consisting of dc voltage which varies as input frequency changes (which amounts to superimposed audio). Low-pass filter wipes off audio and dc goes to VCO to keep it locked to input signal. Unfiltered error voltage from phase detector is the audio modulation of the signal.

is, so long as both inputs are in the same phase relation to each other (usually 90 degrees), output of the phase detector is zero. If the phase of input A begins to lag, output goes positive, and if input A begins to lead the other, output goes negative.

If we could keep an oscillator absolutely stable on the center frequency of an FM transmission, we could feed its output to one input of the phase detector, and feed the other input with the FM signal. The output would then faithfully reproduce the phase differences, which would reproduce the audio signal envelope.

If we could keep an oscillator absolutely stable on the center frequency of an FM transmission, we could feed its output to one input of the phase detector, and feed the other input with the FM signal. The output would then faithfully reproduce the phase differences, which would reproduce the audio signal envelope.

And that's the way the phase-locked loop (abbreviated PLL) works. The phase-detector output is filtered to remove any audio and retain only the dc component, which is a measure of the drift in the local oscillator, and then applied as an "error signal" to the local oscillator to keep it locked in phase with the incoming FM signal.

The filter keeps the voltage-controlled oscillator (VCO) from following the audio, so we pick the audio off ahead of the filter, and we have an FM detector (Fig. 1).

For AM reception, we do things a little differently. We lock the VCO to the incoming signal, just as before, but we add things.

It works out to be something very much like SSB reception; many years ago QST pushed something they called "exalted carrier reception," which involved using two i-f strips, one extremely sharp to pick out the carrier from between the sidebands for high-gain amplification, and the other to accept the sidebands.

Our phase-locked AM reception is just about the same, except that we generate a new carrier in the VCO which is phase-locked to the incoming carrier, and use that to demodulate the sidebands. The demodulation is accomplished in a "multiplier circuit" which is more familiar to most of us as a "product detector" or "mixer." Another low-pass filter shaves off the original input-frequency signal, the VCO signal, and the *sum* frequency from the product detector's output, leaving us the *difference* frequency, which turns out to be the audio we wanted to recover.

Note that this arrangement (Fig. 2) cannot demodulate an SSB signal since

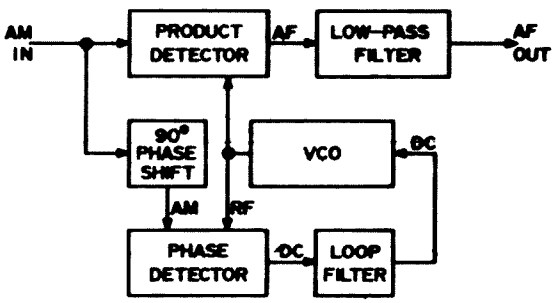


Fig. 2. AM detector using phase-locked loop is a bit more complex. Incoming AM is shifted 90 degrees in phase and VCO is then locked to it. VCO output is used as bfo input to product detector, to recover audio. Low-pass filter in audio signal path removes intermediate, VCO, and sum frequencies, leaving only the difference-frequency output of the product detector.

there is no carrier present for the phase-lock loop to lock onto. In such a case, it would attempt to lock on the strongest sideband component present with notably less than satisfactory results.

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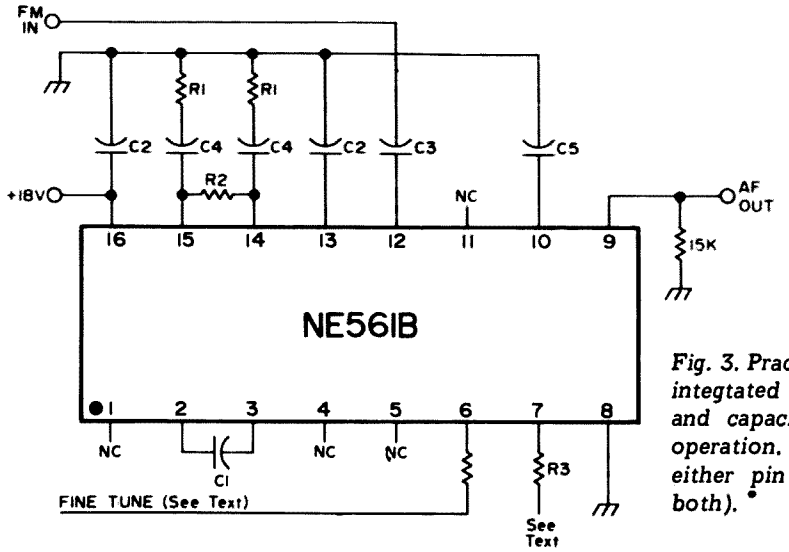


Fig. 3. Practical versions of PLL using integtated circuit with external resistors and capacitors to select frequency of operation. FM input may be applied to either pin 12 or 13 (or push-pull to both).

The 1957 circuit, by Dr. John Costas W2CRR and G. K. Webb WØAHM/2 (both with General Electric in Syracuse, N. Y. at that time), overcame the problem by deriving the control voltage for phase-locking from the sidebands rather than from the carrier. Unfortunately, their circuit has not yet been implemented on an integrated-circuit chip so far as we have been able to learn and so we must wait a bit longer for that happy time.

Right now, though, we can build an FM receiver with excellent performance which will also be able to detect conventional AM, for a small fraction of the cost of conventional receiver circuits.

How Can We Use Phase-Locked Loops?

No new component, no matter how interesting it may be, is of much good to many of us unless we can put it to use. The logical question at this point, then, is "How can we use phase-locked loops?"

In the initial report describing the IC phase-locked loop, Dr. Alan B. Grebene listed nine electronic circuit functions for which he felt it was well suited:

1 – FM i-f strip and demodulator for commercial FM receivers.
2 – Commercial TV sound i-f and demodulator.
3 – Tuned AM detector.
4 – Self-contained SCA (storecast music) receiver.
5 – FM/multiplex telemetry receiver.
6 – Signal conditioner and limiter.
7 – Frequency-shift telegraph receiver.
8 – Frequency selective multiplier and divider.
9 – High-linearity FM detector for wide-deviation FM.

To his list, we can add several more directed specifically at amateur use:

10 – VHF FM mobile receiver for compact cars.
11 – VHF FM handheld receiver.
12 – Frequency synthesis for high-accuracy VHF FM transceivers (*Boelke, 73*, Feb. 1970).

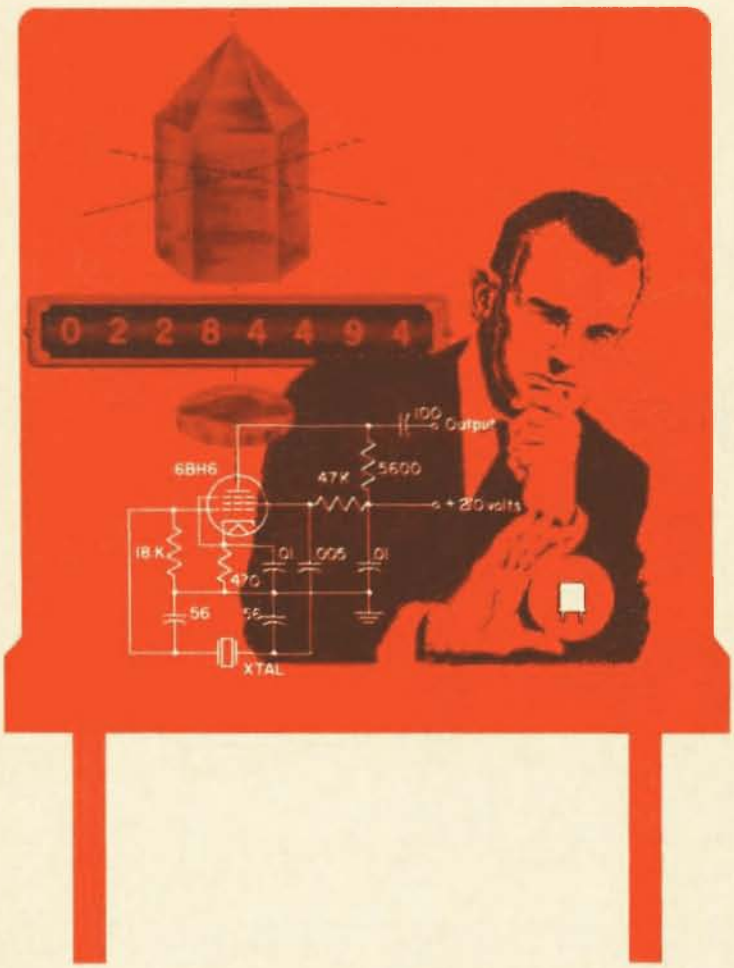
Some of Dr. Grebene's suggested applications are outside our scope, such as the telementry receiver, signal conditioner, and TV sound demodulator. Several of the others telescope into a single application when signal frequencies are ignored – that of a versatile FM receiver. So let's see how to use the PLL (phase-locked loop) IC as an FM receiver, as an AM receiver, as a frequency multiplier, and as a FSK RTTY converter.

Let's emphasize that the circuits which follow are taken from the manufacturer's published applications notes and literature; we have not breadboarded any of them and so cannot guarantee results (but let us know if you have troubles with any of them).

FM Receiver

FM reception is simple with the IC PLL; that's the job it appears to have been invented to do in the first place. When it's running "locked" to a signal, the average dc level of the phase-detector output is

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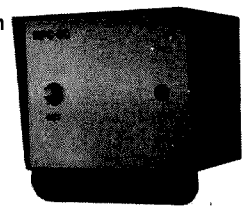
directly proportional to the frequency of the input signal. As the input frequency shifts with modulation, it's this dc output that changes and causes the VCO to shift its frequency to remain locked on the input signal.

The only problem to face in building an FM receiver with the IC PLL is that of setting it up for the proper input signal frequency. The VCO center frequency is set by an external timing capacitor, and by varying the value of this capacitor we can work at any frequency from 100 Hz up to a guaranteed 15 MHz, with typical units operating to 30 MHz and operation as high as 60 MHz possible by a trick we'll pass on a little later.

The connections necessary, as well as the external components required, are shown in Fig. 3. Capacitor C1 is for timing; its value in picofarads for frequencies in the range from 100 Hz to 30 MHz is shown in the left-hand graph of Fig. 4. This capacitor provides a "coarse" adjustment of frequency which can be trimmed by variation of capacitor value. For "fine" frequency adjustment, current must be injected into pin 6 through a series resistor from the power supply; the right-hand graph of Fig. 4 shows the percentage of frequency change achieved for various values of current injection.

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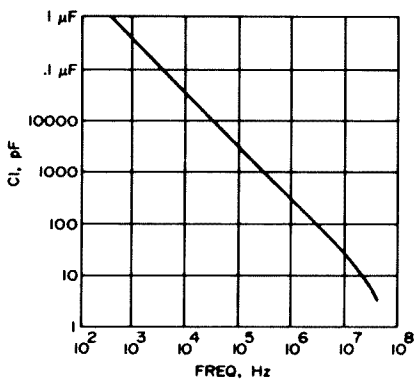


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The other capacitors shown in Fig. 3 are bypass capacitors (C2), coupling capacitors (C3), and low-pass filter capacitors (C4). Their values are dependent to some degree upon the center frequency chosen. The deemphasis capacitor (C5) should be larger than 200 pF for commercial FM reception;



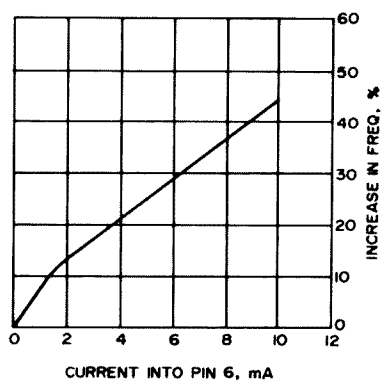


Fig. 4. These two graphs show how operating frequency of VCO in IC PLL is set. Graph at left shows approximate center frequency as value of C1 is changed through the range from 1 μF to 10 pF. This is coarse frequency setting, determining lowest operating frequency. Graph at right shows how frequency increases as current is fed into pin 6; approximately 45% increase in frequency can be attained by this means. This provides "fine tuning" control.

its value is subject to experiment for communications purposes.

Resistors R1 together with capacitors C4 form the low-pass filter; it's fed by an internal impedance of 6 kΩ at pin 14 or 15. Typical values for R1 and C4 are 50Ω and 1100 pF.

The locking threshold of the circuit may be controlled by connecting resistor R2 across pins 14 and 15. Resistor R2 is normally left out, but at high input signal levels or high input signal frequency this reduction in threshold may be necessary to prevent instability. Approximately 6 kΩ is a typical starting point; the value of R2 should be as high as possible in any specific case, though.

Tracking range may be controlled by current injection into pin 7 through resistor R3. If R3 is omitted, tracking range will be approximately 15% of center frequency. When R3 is set to a value which permits 0.65 mA of current to flow into the 600Ω impedance at pin 7, this figure is reduced to approximately 3%.

Other controls are possible, but should not be necessary when the PLL is used as

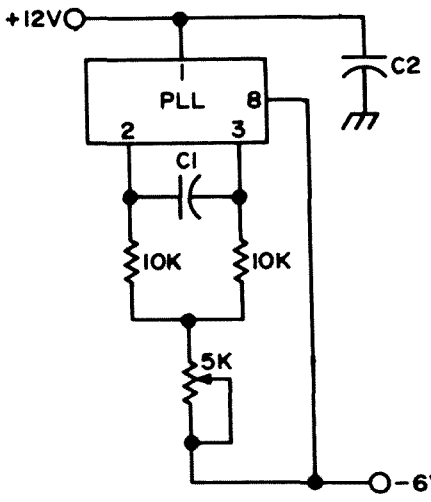


Fig. 5. The NE560/NE561 IC PLL is rated for operation only up to 15 MHz, although many units operate satisfactorily up to 30 MHz. Operating frequency for all units can be increased to approximately 60 MHz by connecting pins 1, 2, 3, and 8 as shown here. This modification can be applied to any of the accompanying circuits. The 5 kΩ pot serves as a fine-tuning control, replacing the current injection into pin 6. If current injection is to be used, the pot can be omitted from this circuit.

an FM receiver. Input signal level should be at least 120 μV to either pin 12 or 13 (the unused input pin should be ac-grounded through a bypass capacitor). Output at pin 9 across a 15 kΩ external resistor (which must be in the circuit; this is an open emitter in the IC) should average 60 mV.

For VHF operation of the PLL, two 10 kΩ resistors and a 5 kΩ pot should be added externally as shown in Fig. 5. According to applications engineer Ralph Seymour, this modification extends the frequency range up to 60 MHz. The 5 kΩ pot provides convenient fine-tuning of center frequency, and may be omitted.

Because of the comparatively high signal level required, and the low input frequency (when compared to the 2 meter band, for instance) a VHF FM receiver for ham use of the PLL would require a converter ahead of the PLL circuit. A block diagram of such a hookup appears as Fig. 6. Note

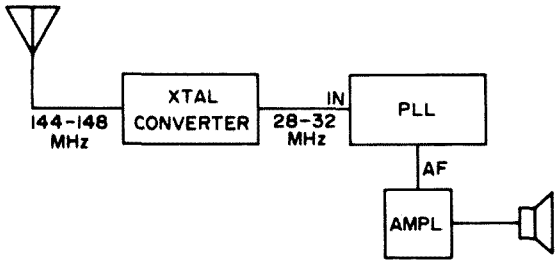


Fig. 6. For ham use as a VHF FM receiver, a crystal-controlled converter ahead of the PLL is necessary. This converter need only provide a moderate output signal level, however, and can be broadband with all receiver tuning being accomplished at the PLL circuit.

that the converter could be crystal-controlled to produce a 28 MHz output; by adjustment of current into pin 6 the PLL can easily be tuned over the full band from a 30 MHz center frequency. This provides, for less than $50, an FM receiver based on the time-honored 75A4 principle of crystal-controlled front end and tunable i-f.

AM Receiver

The AM reception capability of the PLL is something of an "extra." The PLL is

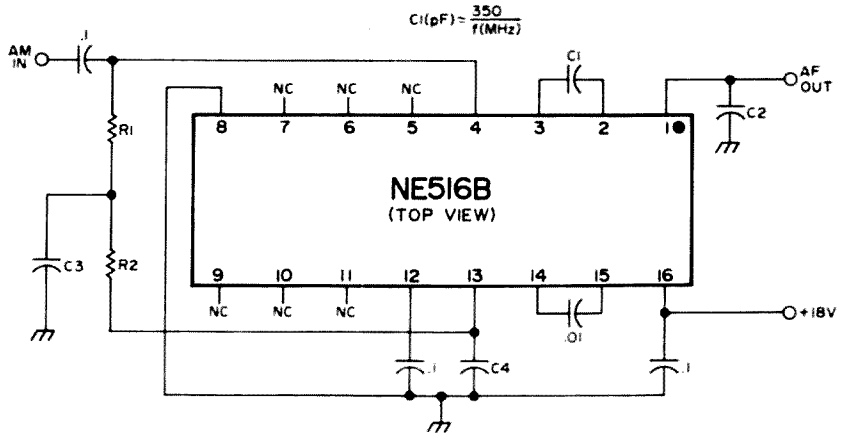


Fig. 7. This is a BC-band AM receiver using the NE561 IC PLL (the NE560 does not include AM detection capability).

locked to input signal carrier frequency and its output is used as the local oscillator to a built-in product detector. A 90-degree phase shift is required to obtain proper operation.

Figure 7 shows the hookup. Bypass and coupling capacitors, all shown as 0.1 μF, should have low impedance at operating frequency (this circuit is intended to cover the BC band rather than HF or VHF). Capacitor C1 is selected to obtain the proper center frequency, and C2 sets the bandwidth by filtering off high-frequency audio output.

The phase-shift network (R1–2, C3–4) provides 90 degrees of phase shift for the rf input signal; the sum of R1 and R2 should be less than 5 kΩ (2 kΩ each was the value used in the prototype) and C3 and C4 should have reactance equal to the values of R1 and R2. For BC operation, 82 pF was chosen.

In this hookup, the low-pass filter is not critical, since no audio is taken from the loop itself; so a simple 0.01 μF capacitor from pin 14 to pin 15 suffices.

Tuning may be done in either of two ways. The first is more straightforward but the second is elegant. The first way is to vary the value of timing capacitor C1. For BC operation, C1 should tune from a minimum of 220 pF (for 1600 kHz) to a maximum of 620 pF (for 500 kHz). The classic receiver alignment technique of padding capacitance is used at the high end of the range, but at the low end varying the current into pin 6 (fine-tuning control) takes the place of adjustment of inductance.

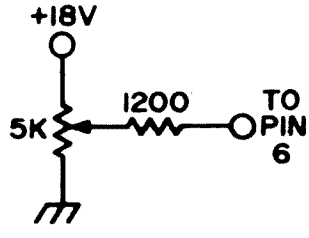


Fig. 8. This simple arrangement for connection to pin 6 of NE560/NE561 provides fine tuning over a 3:1 range. The 1.2 kΩ resistor limits maximum injection current. Timing capacitor should be set for lowest frequency with pot arm at ground, and 1.2 kΩ resistor then trimmed to set highest frequency desired, with pot arm at hot end.

The second method of tuning the receiver uses a fixed value for C1. This value is whatever is required to make the VCO operate at 940 kHz (geometric mean frequency) when the current at pin 6 is zero. Pin 6 is then connected through a 1.2 kΩ resistor to the arm of a 5 kΩ pot (Fig. 8) across the 18V power supply. Varying the pot tunes the receiver across the BC band using only the fine-tuning feature.

This receiver requires an antenna and a good ground; it must get at least 100 μV from pin 9 to ground. Operation will be improved by using a broadband untuned rf amplifier, but care is necessary to assure that the PLL is not overdriven (maximum input signal if 1V rms). Maximum audio output is 2V p-p, and typical output is about 60 mV.

Frequency Multiplication

The PLL IC can be used as a frequency multiplier in several ways. The simplest is merely to set the center frequency to some multiple of the actual input signal frequency. However, as the higher (and thus weaker) harmonics are used for locking, the lock range decreases. If input frequency is fairly stable and rapid tracking is an opportunity for use as a frequency marker. Two PLLs in series could produce a 1 MHz standard from a 100 kHz crystal, and in turn a 10 MHz standard from the 1 MHz standard. One great advantage of the PLL multiplier as compared to a multivibrator or a conventional tuned-amplifier multiplier is that the order of multiplication can be changed merely by changing center frequency (such as with switched timing capacitors). This would permit generation of a 3.5 MHz square wave as the seventh multiple of a 500 kHz standard, giving you strong markers at the bottom edge of every HF ham band.

The PLL multiplier will divide frequency just as easily as it multiplies. If center frequency is adjusted to be one-third that of the input signal, the circuit

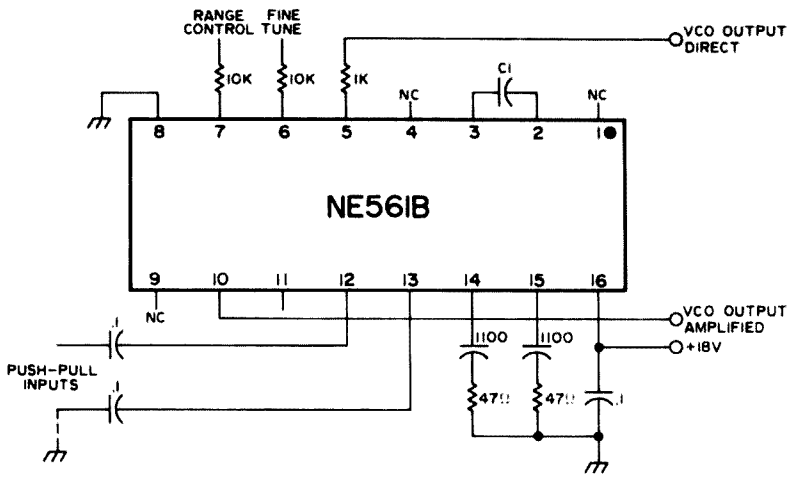


Fig. 9. PLL makes fine frequency multiplier or divider. For this application, audio output connections are ignored and the VCO output is used instead. If input is single-ended, one of the two push-pull input leads should be bypassed to ground as shown by dotted lines. Circuit will multiply up to 10 times, and divide input frequency by 3, 5, 7, or 9. C1 and fine-tuning adjustment must be set for operation near desired output frequency. When input is applied, VCO will lock to exact multiple or odd submultiple of input if it is within locking range and of adequate strength.

not required, this technique can be used to multiply by 2, 3, 4, or 5 times any input signal. Output of the VCO at pin 5 is a square wave.

Action of the PLL as a multiplier can be improved by converting the input signal to a square wave, which has much stronger harmonics than does a sine. When this is done, any output frequency up to 15 MHz can be produced from its tenth subharmonic (multiplication of up to 10 times).

Since the PLL output is already a square wave, rich in harmonics, this offers still locks. This action occurs only for *odd* submultiples, however; for even divisions (half, quarter, eighth) it doesn't work. You can divide 3, 5, 7 or 9 only.

Extensions of these features make possible the construction of simple frequency synthesizers; too many PLLs are required to make them practical at present prices, but when costs come down they may well be worth investigating. Collins Radio's book "Fundamentals of SSB" (out of print since 1962, unfortunately) gives the principles involved if you're interested.

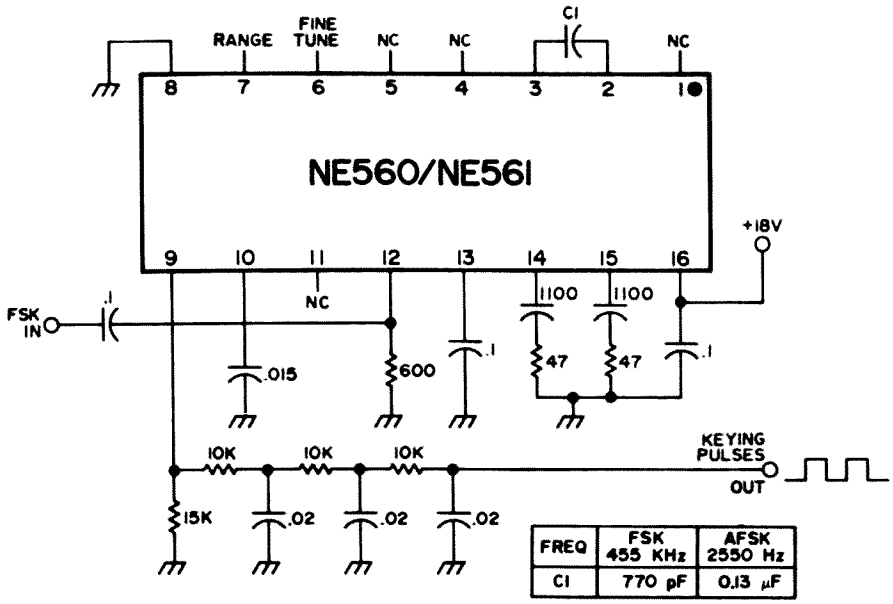


Fig. 10. RTTY converter circuit is taken from computer data set applications note; data set is same as AFSK converter, but gets input signal from telephone line and so is not subject to such high levels of interference as is RTTY. Input may be either at i-f or audio frequencies; table shows values of C1 for both cases. Output consists of pulses which may drive a keying circuit for selector magnets.

The hookup for use of the PLL as a frequency multiplier or divider is shown in Fig. 9.

FSK Converter for RTTY

Using the PLL as an RTTY FSK converter is almost identical to its use as an FM receiver, because FSK (or AFSK) is merely a means of carrying binary or telegraph (mark–space) information by means of frequency modulation. The frequency shift involved is usually rather small – but so is that for FM, in comparison with the center frequency.

The FSK input, either at communications-receiver i-f for FSK or at audio frequency for AFSK, is applied to the FM input of the PLL. The loop filter capacitor is made smaller than usual to eliminate any possibility of "overshoot" in the output pulse,

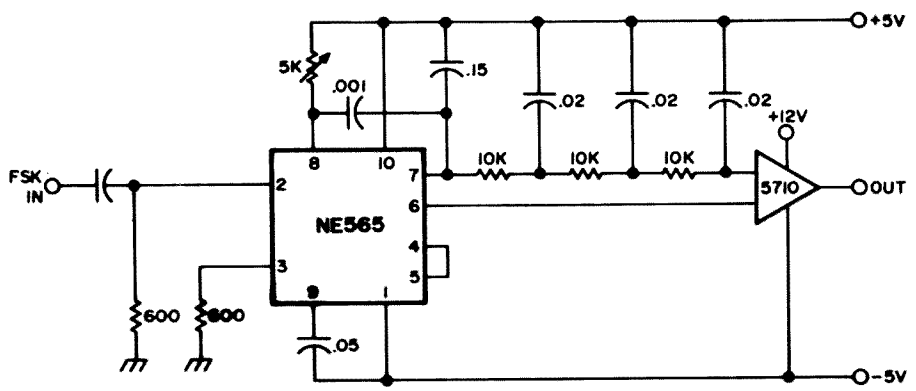


Fig. 11. Alternate RTTY circuit uses NE565 IC, which is so new that its price is not listed yet. Maximum frequency of 565 is 500 kHz. This circuit is designed to drive digital IC devices, and type 5710 voltage comparator is included to adjust output level to values suitable for digital ICs. Pot is for frequency adjustment.

and a three-stage ladder filter removes the carrier component from the output (this is necessary only for AFSK). The center frequency is adjusted to produce about 12V at the output when the input frequency is at its lower figure. When input frequency rises to its other figure, output will rise a maximum of 4V as the VCO tracks the input-frequency change. This voltage change is coupled out through output coupling capacitor to drive any external circuits desired, such as a magnet driver.

The circuit is shown in Fig. 10. Figure 11 shows an alternate circuit using a different type of PLL chip together with an IC voltage comparator at the output to change the output levels to values which are compatible with normal digital IC chips. In this case, center frequency is adjusted to produce a slightly positive voltage at the output, when input is at the low frequency.

SCA Adapter

The PLL's capability to receive FM at almost any center frequency comes in handy if you like background music from the "storecast" services sold by many commercial FM stations. These storecast signals are transmitted as FM of a 67 kHz subcarrier which is itself a part of the normal FM signal. To receive them with the PLL, all you need do is set up the PLL for a center frequency of 67 kHz and tap off an output from your FM receiver ahead of the deemphasis filter (which bypasses the 67 kHz signal to ground) to feed the PLL. PLL output will then be the background music, which is free of all interruptions such as commercials or even station identification.

One precaution may be necessary. The signal from the FM receiver to the PLL input should go through a high-pass filter to prevent any possibility of overload by the much stronger audio of the normal broadcast program or any accompanying stereo information at 38 kHz. A typical hookup using the NE565 PLL is shown in Fig. 12.

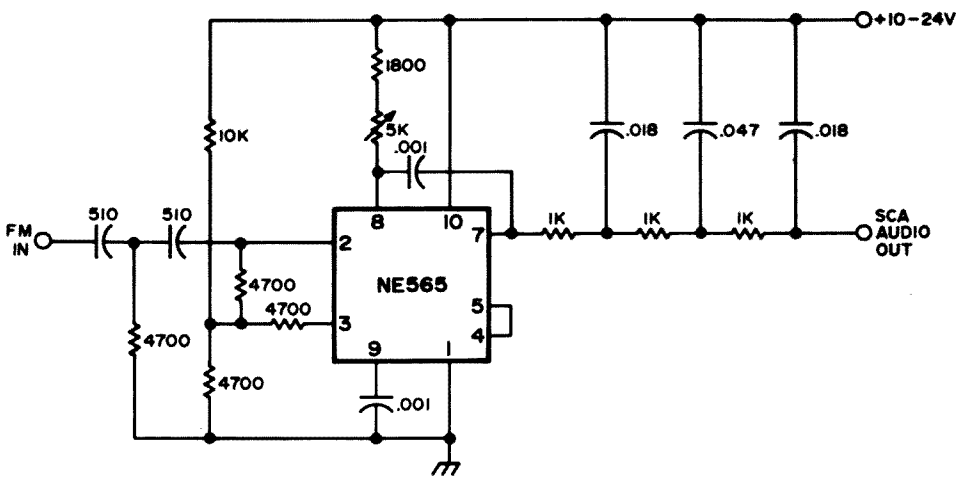


Fig. 12. Background music adapter for FM receivers uses type 565 IC PLL. 510 pF capacitors and 4.7 kΩ resistors at input form high-pass filter to keep audio from FM set from overloading PLL; ladder filter at output removes everything above about 10 kHz to keep from overloading audio amplifiers following. Pot allows frequency to be adjusted to 67 kHz to pick off SCA subcarrier.

The Source

About the only thing we haven't yet told you about the PLL IC chip is who makes it and where they can be obtained.

The manufacturer is Signetics Corporation, a subsidiary of Corning Glass Works and one of the leaders in the integrated-circuit industry for a number of years now. The PLL IC is only one of many chips in their line (their price list as of 4 May 1970 required 21 pages merely to list prices of current IC products).

Signetics is located at 811 E. Arques Avenue, Sunnyvale CA 94086, and we obtained our information from Ralph Semour, linear applications supervisor.

Three ICs Contain Entire Phase-Locked Frequency Synthesizer Loop

Except for the reference frequency component, designers can build the phase-locked frequency synthesizer loop portion of a system using just three IC packages. This is possible through the use of three new Motorola TTL circuits: a dual voltage-controlled multivibrator, type MC4324/4024; a phase frequency detector, type MC4344/4044, and one of two soon-to-be introduced modulo-N programmable counter, types MC4018. These three functions replace from 8 to 15 IC and discrete packages in a conventional phase-locked loop system.

The MC4324/4024 is a monolithic IC that contains two independent voltage-controlled multivibrators (oscillators). The frequency of the MTTL-compatible outputs can be varied over a range of 3.5 to 1 by using a dc control voltage of +1-5V.

The MC4344/4044 is a monolithic phase detector that converts TTL logic levels to a dc voltage level for use in frequency discrimination applications. In operation, the output from either of two internal phase detectors is fed to a charge pump that converts the outputs to fixed-amplitude positive or negative pulses. These pulses are applied to a lag–lead active filter that generates a dc voltage proportional to the phase error between the input and reference signals at the inputs of the phase detectors.

They make the PLL in several different models, with model numbers to match. The one shown in most of these diagrams is the NE561B, which is the most general in application. It includes the AM-detection capability, and quoted price in lots of 1-24 is $37.50 each. The NE560B is virtually identical but does not include the AM detection features, and lists at $30 each. Models NE565 and SE565 (the N indicates *commercial* temperature range; the S means *military* range) are too new to be listed; they operate only up to 500 kHz and so presumably would be lower in cost. The 565 is used in the circuits of Figs. 11 and 12. Finally, the NE562 is intended for direct interface with digital logic systems and, like the 565 it is too new to have an established price yet.

Pin connections for the 560, 561, and 565 are shown in Fig. 13.

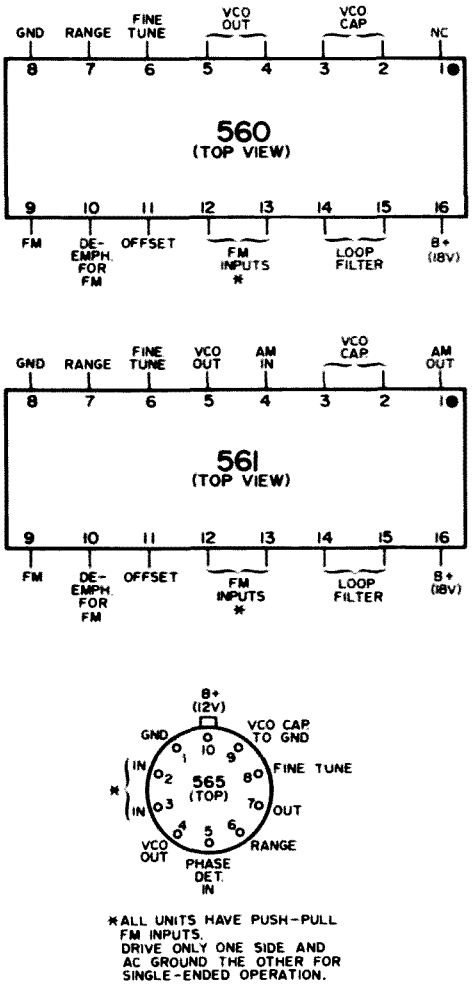


Fig. 13. Pin connections for types 560, 561, and 565 Plls are shown here. Only difference between 560 and 561 is that 561 has Am detector included where 560 has additional VCO output lead.

The N5710T comparator shown in Fig. 11 sells for $2.62 each in lots of 1–24.

All of these (with the possible exception of the 562 and 565, which were still *preliminary* designs at this writing) may be obtained on special order from the manufacturer. In addition, the major mail-order houses catering to the industrial electronics trade may be able to obtain them although no catalog available to us lists Signetics as one of the lines carried in stock (the firm deals primarily with the original-equipment-manufacturer market). Inquiries should be addressed to Mr. Seymour and should mention this article.

... K5JKX ■

Richard Factor WA2IKL
30 West 60th St.
New York NY 10023

A LOW COST FUNCTION GENERATOR FOR THE EXPERIMENTER

Most experimenters have audio frequency oscillators, yet their use is severely limited by the lower frequency limit of about 20 Hz in most low-cost units. This limitation exists because of the extremely high impedance necessary to avoid loading the frequency determining network. Until the advent of the field-effect transistor (FET) it was almost impossible to build a low-distortion, low-frequency transistor signal generator. It is still difficult to lower the output frequency significantly without introducing severe distortion.

The unit described in this article has none of the low-frequency limitations of bridge-type oscillators. It generates signals in the range of 4 kHz down to about 10 mHz (that's 10 millihertz, or 0.01 cycle per second!). Such frequencies have many uses, such as generating slow-sweep displays, checking the response of low-frequency filters, and voltage-control applications in electronic music generation, instrumentation, etc. The circuitry is similar to that of a high-priced laboratory instrument known as a "function generator," but by taking advantage of low-cost ICs and nonprecision resistors, it can be built for substantially less than most kit-type audio generators.

Circuitry

Most audio oscillators directly generate a sine wave. Sine-wave oscillators usually are much more critical than other types. The oscillator of Fig. 1 generates a triangular wave which is then shaped into a sine wave using a FET instead of a reactive filter. This renders it insensitive to frequency, enabling the distortion to be constant over the entire range. Due to difficulties in obtaining precise symmetry in FET characteristics, plus nonideal characteristics of the transfer function itself, it is difficult to get the distortion lower than about 1.2%. This is adequate for almost all applications.

Integrated-circuit operational amplifiers (opamps) are used to generate the triangular wave. Unit A2 is connected in a circuit arrangement known as an integrator. Time-determining capacitor C_t is charged at a rate directly proportional to the current fed into pin 2 (the inverting input) of the opamp. Pin 2 is kept at ground potential by feedback through the capacitor, so the current equals the voltage at point V_c divided by the total series resistance, consisting of the resistor on the octave switch and the range trimmers. Thus, it is possible to control the charging

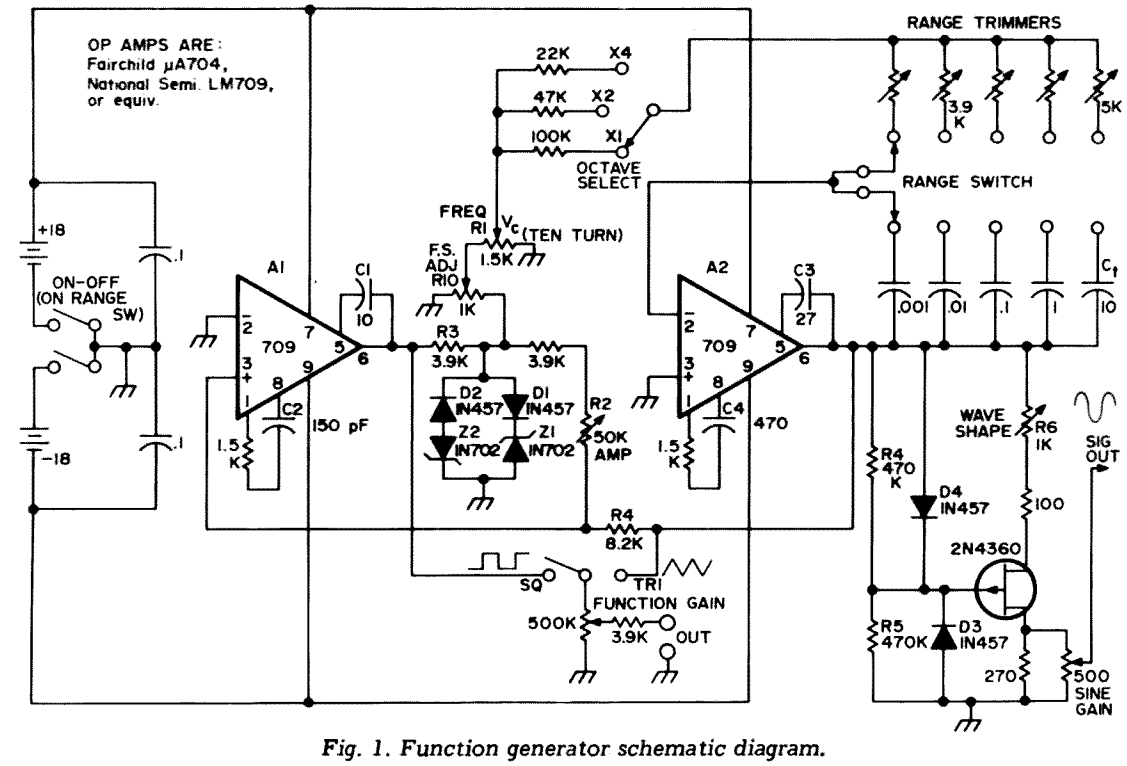
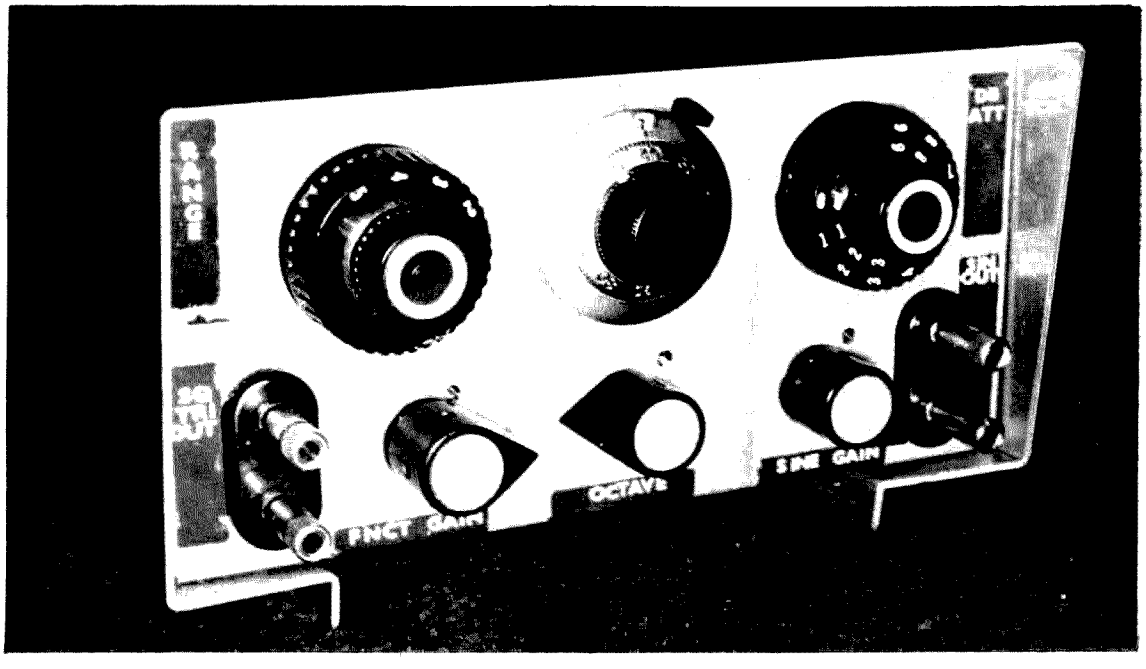


Fig. 1. Function generator schematic diagram.

rate with R1, and the high current capacity vs low leakage current of the opamp allows the charging rate, and hence the frequency, to be varied over a 500-to-1 range, compared to the normal 10-to-1 range for normal capacitance-controlled oscillators.

If a current were just fed into the opamp, the capacitor would continue charging until the limit imposed by the opamp and the power supply voltage was reached. However, A1 is connected to the frequency control pot, and supplies the voltage that is converted into the charging rate by the various resistors. A1 is connected in a positive feedback loop with high hysteresis. The opamp is sensitive to the

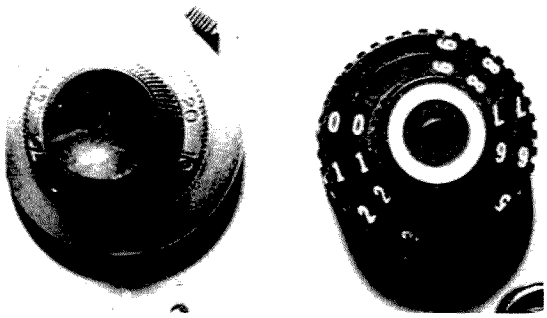


Front panel of function generator.

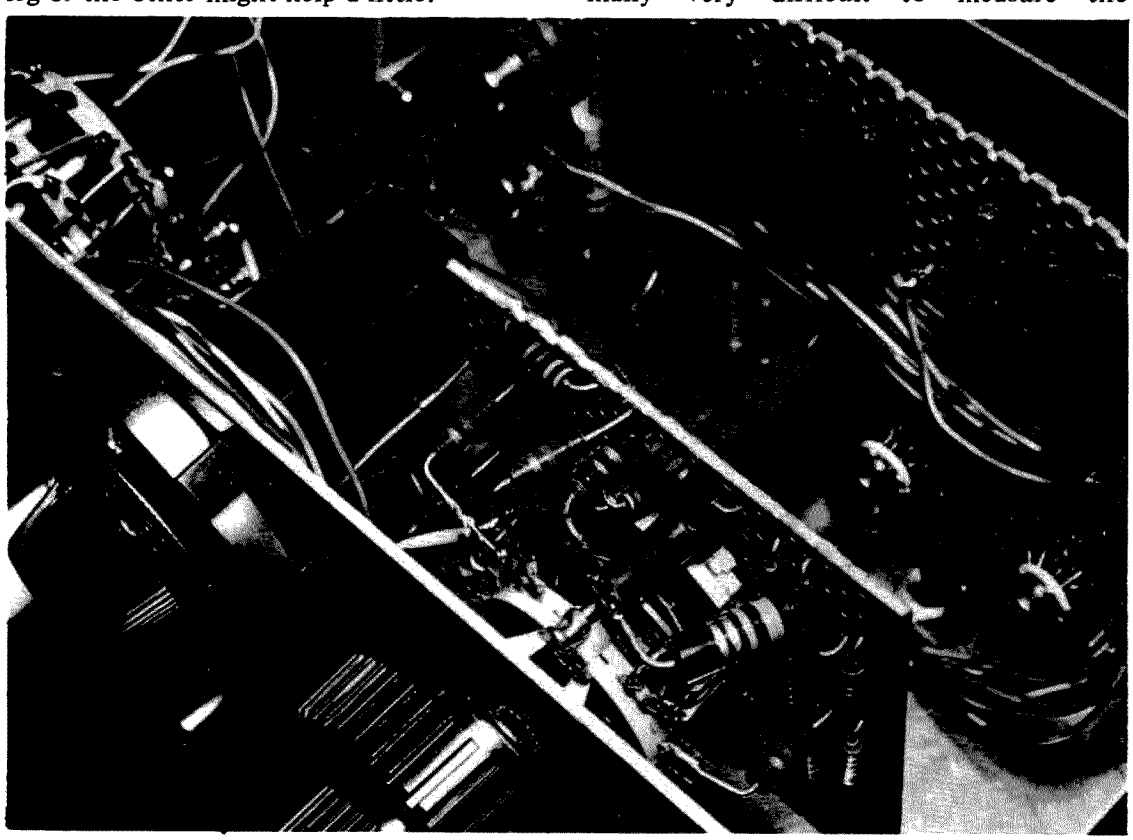
voltage between the two input terminals. If the difference is only a millivolt or so, the amplifier goes to either its fully positive or fully negative limit, depending on the input polarity.

Feedback to the input is through R2 and R4. Assume the output of A1 is fully negative. This voltage is clamped to about 4V by D2 and Z2 (D1 and Z1 when positive). This 4V is connected back to the input through R2 (and the 3.9 kΩ protective resistor). As the voltage at the output of A2 gets increasingly more positive, a point is reached where the current through R4 becomes opposite to and slightly greater than that through R2. When this happens, the amplifier instantly (in a few microseconds) changes state, aided by the positive feedback through R2. Of course, when the opamp changes state, the integrator starts to charge in the opposite direction, thus creating the triangular wave. The zener diodes insure that the wave is highly symmetrical. If your zeners are out of tolerance, or distortion is critical, connecting a small resistor in one leg or the other might help a little.

The sine wave, square wave, and triangle wave are all synchronous and available simultaneously. To conserve panel space on my unit, I used a switch to connect either the square or the triangle to the binding post, though this is not necessary. Whatever arrangement you use, avoid loading the output on the opamp by more than about 2 kΩ. It won't harm anything, but the output frequency may change slightly when connecting and disconnecting loads if this precaution isn't observed. It is normally very difficult to measure the



Front panel view of frequency control dial and step attenuator dial.



Interior view of unit with step attenuator resistors in front.

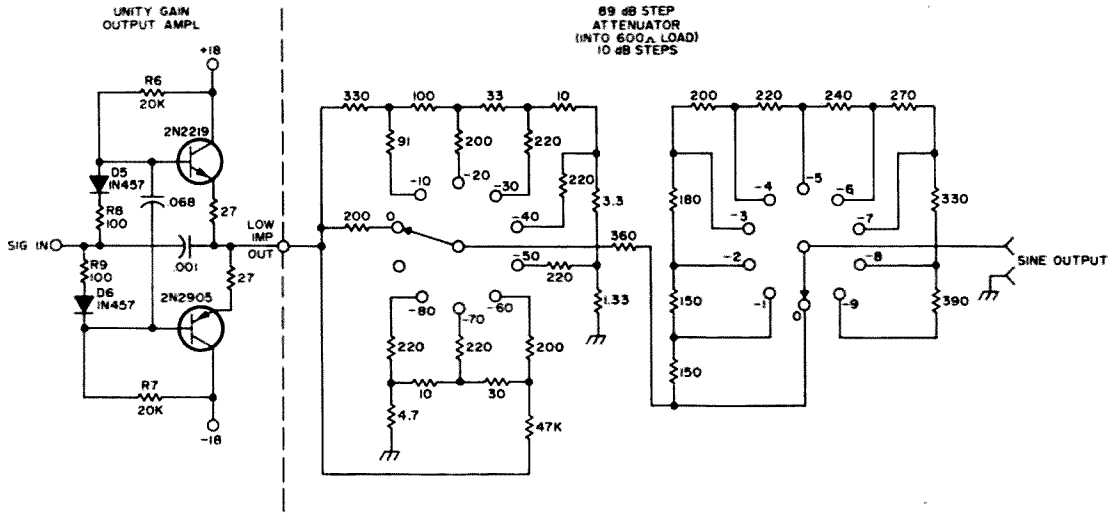


Fig. 2. Output amplifier and attenuator schematic.

frequency of VLF sine waves. Connecting the square wave output to a counter while using the sine output is a great convenience.

The sine wave shaper takes advantage of the symmetry of the source and drain with respect to the gate of the 2N4360 J-FET. (This unit was chosen primarily for its very low cost, as well as its relatively high pinchoff voltage which gives a greater output voltage.) The output of A2 varies symmetrically about ground, and as the absolute value of the voltage increases, the FET resistance also increases due to the gate bias. Incidentally, note that the power to drive the FET circuit is supplied directly by the opamp output. Proper bias polarity is insured by D3 and D4.

Since the output is symmetrical about ground, no coupling capacitors are necessary. It would be hopelessly unwieldy to use one for 0.01 Hz anyway. The output amplifier is designed for unity gain with no voltage offset. Simplicity is achieved through the use of complementary transistors. The output impedance is under 100Ω. Resistors R6, R7, R8, R9, and diodes D5 and D6 are the bias network, which eliminates crossover distortion in the amplifier.

If you plan to use the equipment for checking professional audio equipment, you might desire to add the attenuator shown in Fig. 2. It provides 89 dB of attenuation into a 600Ω load. Two concentric single-pole, 10-position switches break the 89 dB into 1 dB steps.

To simplify the attenuator design and allow the use of standard resistors with 5% tolerance, an unususal circuit was used. The 10 dB steps are provided by a constant-impedance (200Ω) "T" attenuator, and the single dB steps are provided by switching in series resistors. Thus, the attenuator is not of a constant-impedance design, although the voltage into a 600Ω load conforms to the proper setting.

If you are using a high-impedance load, the output should be bridged with a 600Ω resistor. A low-impedance load will exaggerate the effect of the 1 dB step switch.

I emphasize that this whole assembly, while desirable, is purely optional.

Adjustment

As you can see from the photograph, the frequency control is a 100 turn precision potentiometer. These are readily available for a couple of dollars in the surplus market. Using one, it is possible to calibrate the unit so that for the top 900 divisions, the output frequency is correct to within 1%. As the octave select switch is switched to a lower series resistance, the linearity of the frequency control is decreased. The full-scale adjustment pot sets the output frequency to 100 Hz on the range with the .01 μF capacitor when the octave switch is in the X1 position (100 kΩ series resistance). Then the various range adjust pots are set until each range

has the appropriate full-scale value: 1 kHz, 100 Hz, 10 Hz, 1 Hz, 0.1 Hz.

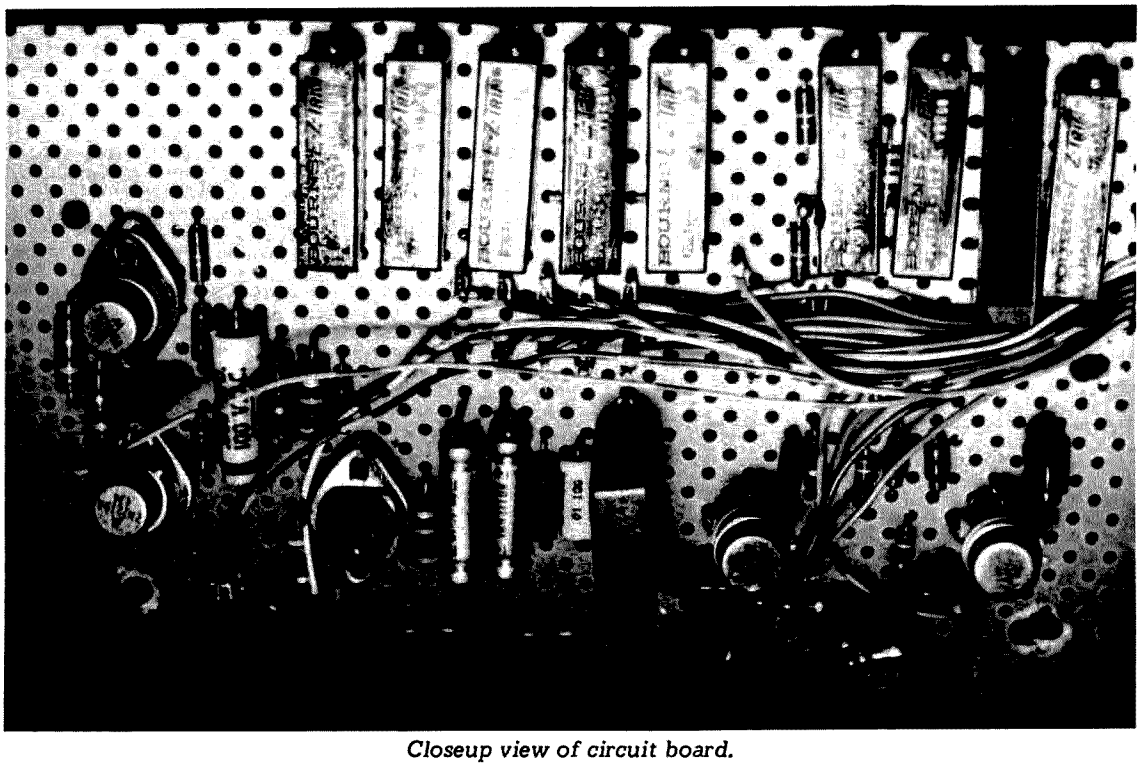
Potentiometer R2 is adjusted so that the triangle amplitude is proper for conversion to a sine. This control interacts with the full-scale adjustment pot, so they both may have to be readjusted several times. Waveshape pot R6 is adjusted for symmetry in the top and bottom halves of the sine wave. A scope or harmonic distortion meter is advisable for the above two adjustments, although a reasonable null can be achieved by a musically trained ear, especially if there is an undistorted signal available for comparison.

Construction

The circuitry is noncritical and any convenient layout may be used. Power is provided by four 9V batteries. Do not exceed this voltage as the operational amplifiers are rated for a maximum power supply potential of ±18V. The batteries should be bypassed with 0.1 μF capacitors.

If any trouble is encountered with the opamps oscillating at high frequency, it will probably be eliminated by bypassing the power supply pins to ground as close to the IC as possible. If this doesn't work, add capacitance to C1, C2, C3, and C4 a few picofarads at a time until oscillation stops. The values given in the diagram are calculated to work with almost all production opamps, but occasionally one will be near the edge of the specifications and require the extra capacitance.

If you don't need precise frequency calibration or attenuation, substantial cost can be saved by eliminating these features. The range trimmers can also be eliminated (just replace with a short circuit). The octave switch can be replaced with a fixed resistor down to 15 kΩ or so. The output attenuator can be replaced with an ordinary pot; and substitute the 500Ω pot and 470Ω opamp resistor before the amplifier with a 240Ω resistor; and connect the opamp input directly to the FET. The pot must be connected to the amplifier output to attenuate the amplifier noise as well as the signal. Use any convenient pot for the frequency control, and calibrate the dial yourself.



Closeup view of circuit board.

Following these procedures can reduce the cost to under $10 and yet provide you with an oscillator that, in the lower frequency ranges, is better than anything selling for under the price of a laboratory function generator.

...WA2IKL ■

CONTROLLING Repeaters WITH TONES

by Ken W. Sessions, Jr. K6MVH

A few years ago, an amateur repeater typically consisted of not much more than a transmitter and a receiver, interconnected to operate as a repeater. But a number of factors have served to bring about a trend toward limited control of the repeater through the use of audio tones transmitted on the repeater's input frequency. When two repeaters are close enough to one another so that a user station triggers both repeaters when he attempts to use but one, a tone system is called for. When a group of amateurs band together to put up a repeater for the exclusive use of material supporters, again tones are required. When the repeater input frequency is commonly used for a simple channel (point-to-point, or direct), a tone system is the only way to insure that the repeater is only triggered when it is actually being used by one of the stations on the frequency.

Today, the toned repeater is at least as common as the straight "carrier-operated" repeater, and the trend towards tone control is certain to increase from here on out.

The three most common methods of tone control for amateur repeaters are, in order of popularity, "tone burst," "whistle-on," and "continuous-tone-carrier-squelch." The first two systems employ the use of a relatively high-pitched audio tone of short duration. The latter employs a continuously transmitted very-low-frequency "subaudible" tone of a specific and usually quite critical frequency. Each system has advantages the others do not share. It is up to the repeater designers to look at the merits of the three systems, then adopt the one that best meets their particular needs.

A tone-burst system installed in a repeater will require each user to transmit a short tone "burst" each time he wants to communicate through the repeater. The only practical method of utilization in such systems is for each user to install a tone oscillator in each of his transmitters, along with a simple timer to limit the duration of each tone burst, and a method for automatically keying the oscillator each time the transmitter push-to-talk circuit is actuated. Each user should also install a switch so that he can take the tone oscillator out of the circuit when he is not operating through the repeater.

But on the plus side, the tone-burst system is the simplest of all the systems to install at the repeater; it will consist of nothing more than a single relay and a

timer to limit length of each transmission (assuming that a tone decoder is already installed at the repeater site).

The whistle-on system is the nicest from the standpoint of the users, who must possess no oscillators other than the one with which they were born. A simple brief whistle will turn on the repeater, and the repeater will operate from that point on in a purely carrier-operated manner. After a specified time period of inactivity (say, no incoming repeater signals for five minutes), the repeater will shut down. To turn it on again, the next user will have to command it with another orally produced whistle. As with the tone-burst system, the whistle-on approach includes a transmission-limiting timer of a minute-and-a-half or so.

The whistle-on concept offers the most in terms of flexibility, but it requires two timers and a relay (in addition to the broad tone decoder). Interconnection, however, is quite simple.

The third approach, continuous-tone-carrier-squelch (most frequently referred to by Motorola's tradename of *PL*, for "Private Line"), is the least flexible, the most difficult to implement, and the most critical with respect to audio stability. It is also the most secure of the three, which is one of the reasons many amateurs elect to use this system for their "closed" repeaters.

There is little complexity at the repeater site with a PL system, since nothing other than the decoder itself is actually required, even though most amateurs like to add a delayed-dropout relay to avoid "chopping." But the problems faced by the users are manifold. Here, every transmitter that is intended to be used with the system must be equipped with highly stable low-frequency tone generators. And, unless great care is taken in the setup of all the stations, the repeater in use will sound like a bunch of stations who use unfiltered power supplies. A good PL system should be subaudible, but amateur setups – commercials, too, for that matter – seldom are.

Basic Control Logic

Once the type of tone access approach is chosen, the repeater should be set up to provide the widest possible number of logic outputs, which can be used for an almost endless array of later control functions. The tone decoder, for example, should drive a relay to provide voltage and ground outputs when the proper incoming tone is sensed. And the carrier-operated relay should likewise be set up to drive a multicontact, heavy-duty "slave" that provides voltage and ground output signals for both the *signal* and the *no signal* states. These logic signals will prove invaluable as additional control functions are implemented.

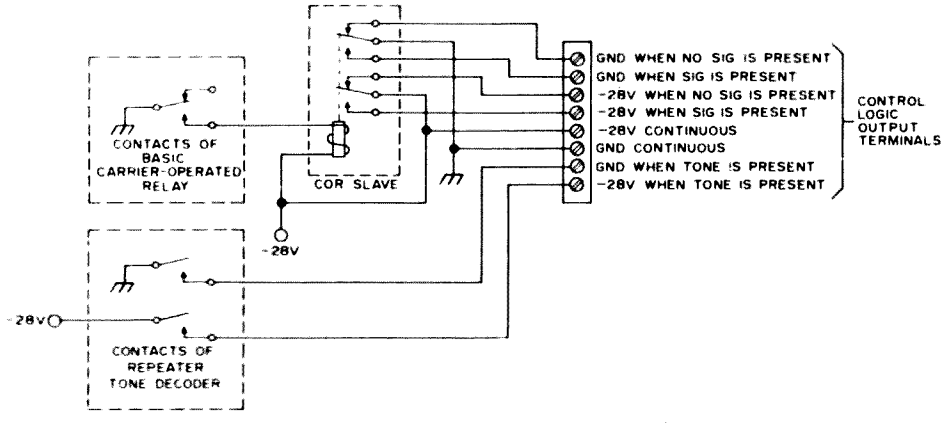


Fig. 1. A heavy-duty relay slaved to the carrier-operated relay, along with ground and voltage outputs from the tone decoder, can be used to provide a variety of very useful logic signals for all repeater control functions.

The circuit of Fig. 1 shows how the logic signals are obtained and what they are. The control circuits described here and in other "repeater control" articles will always require at least some of the logic signals available on the terminal board.

Control Logic and PL

A good example of how the logic signals can be used appears in Fig. 2, which is the heart of a PL control system. The coil of a delayed-dropout relay is fed with the ground output of the tone decoder and the voltage output from the carrier-operated relay. If the tone is erratic, the relay stays keyed because of the timer's delay of a half-second or so. But, since the carrier-operated relay ground output signal is used to key the transmitter push-to-talk circuit directly (through the contacts of the delay relay), any loss of signal will cause the repeater to shut down immediately. Thus, there is no "delayed squelch" arrangement, yet the users are protected from fluttering of the repeater that might be caused by borderline settings of their tone units.

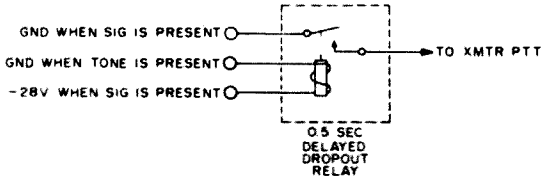


Fig. 2. There are many methods for keying continuous-tone-carrier-squelch (PL) systems, but those employing delayed dropout relays are the most successful. Here, the tone and the signal must be present to hold the repeater on the air. Momentary tone variations because of weak signal will not cause "cycling" because of the delay, but the repeater will drop out instantly if the carrier itself drops out.

Control Logic and Tone-Burst

The relay and timer circuit of Fig. 3 shows how the basic repeater logic signals can be used to control the tone-burst repeater. When a signal appears without the proper accompanying tone, the normally open contacts of the repeater control relay keep the COR ground signal from being fed to the repeater push-to-talk circuitry. When the correct tone appears, however, a ground signal from the tone decoder energizes the coil of the repeater control relay (whose voltage is supplied through the normally closed contacts of a 1.5-minute timer). The control relay pulls in and is latched by the COR ground signal now being supplied through the relay's own contacts.

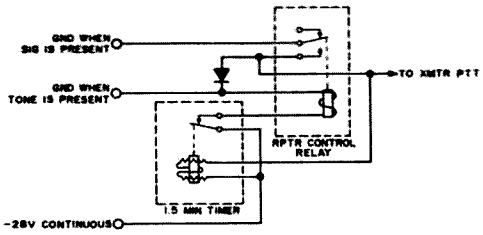


Fig. 3. Tone-burst repeaters can be set up with nothing more than a relay and a timer if the decoder and COR logic signals are available. Here, a short tone burst will energize the control relay, which latches as long as a carrier stays on the input. If the carrier stays on more than 1.5 minutes, the repeater will go off the air and a new tone will be required. Each transmission must be accompanied by the proper tone burst.

Even though the tone burst is short, the repeater control relay will keep the transmitter on the air as long as a signal stays on the input frequency – unless that time period happened to exceed a minute-and-a-half.

The timer is keyed at the same time the push-to-talk circuit of the transmitter is energized. And if the same signal is present for the timer's full period, it will pull in to break the circuit on the repeater control relay. The only way to get the transmitter on the air again if this occurs is for a new carrier to come on the frequency with the proper tone.

The control relay also drops out when any carrier disappears, so that each station who wants to use the repeater must either "tail-end" (seize the frequency before the preceding user drops his carrier) or be equipped himself with the proper access tone burst.

The diode in the circuit, by the way, is to keep the tone decoder ground signal

from being overworked. Without the diode, the decoder ground signal would have to key the transmitter push-to-talk and the transmission-limiting timer. With the diode, the tone decoder ground can only trigger the repeater control relay.

repeater will shut down. Another whistle must be sent to bring the repeater on again.

As with the tone-burst system, a timer is typically employed to limit the length of transmissions going through the repeater. Figure 4 shows the circuit and the logic

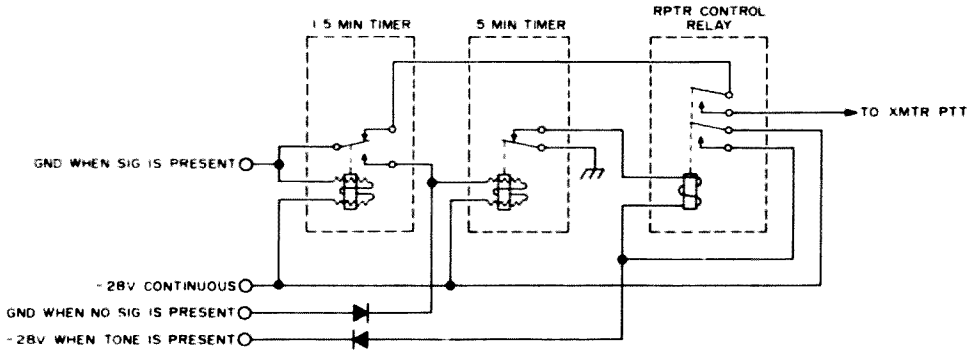


Fig. 4. The complete whistle-on control system contains two timers and an ordinary relay. If a carrier stays on for more than 1.5 minutes, the push-to-talk circuit is disconnected. If the carrier stays on 6.5 minutes, the repeater shuts down and must be whistled on again. Also, if nobody uses the repeater for 5 minutes, shutdown will occur.

Control Logic and Whistle-On

Not many people really understand the "whistle-on" approach. Some amateurs seem to think that if they can whistle to bring a repeater on the air, that process constitutes a whistle-on system. However, in spite of the fact that many tone-burst systems can be accessed by a whistle, a true whistle-on system is one that has been designed for access by whistling. And to be convenient, no whistle approach can require the users to whistle each time they transmit.

A whistle-on repeater may stay off the air for long periods. Stations can transmit as much as they want on the input frequency, but no repeater will be around to assist in their communications unless one of the users decides to call up the repeater by uttering a brief whistle. When the tone decoder at the repeater senses the presence of the whistle, on comes the repeater, *as a conventional carrier-operated system as long as the repeater is active with users.*

When the users all drift away, and the repeater becomes inactive, the repeater starts counting time. After a specified period, usually five minutes or so, the

required to produce a sound whistle-on repeater system.

Normally (when the repeater has not been whistled on), incoming signals cannot be fed to the push-to-talk because the COR ground signal goes no further than the normally open contacts of the repeater control relay. When the whistle is sensed, however, decoder voltage causes the control relay to pull in (and latch). Now all signals, tone equipped or not, will be repeated.

When a single transmission exceeds 1.5 minutes, the COR ground signal causes the timer to pull in and disconnect the push-to-talk. If the user was simply longwinded, he'll quit transmitting in a minute or two and the system can go right back into normal operation, with no new whistle required. But if the problem is more serious than a longwinded ragchewer, the whole repeater will shut down completely in five more minutes. The COR ground is rerouted after the first minute-and-a-half to the five-minute timer, which causes de-energization of the repeater control relay at the end of its period.

The five-minute timer is also used to shut down the system when nobody is

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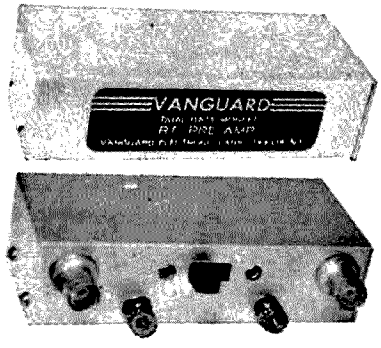
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using the repeater. A ground signal from normally closed contacts on the COR slave relay completes the circuit on the timer coil. This "double duty" provides for an extremely safe and self-controlling repeater system.

As with the tone-burst circuit, the diodes in the whistle-on system are for isolation. The one in the *no signal present* ground line keeps the circuit isolated from the *signal present* logic. The diode in the negative voltage line isolates the *tone present* signal from the *continuous −28V.* terminal.

Tone Access and the FCC

The Federal Communications Commission has been riddled with requests from amateurs seeking to get a relaxation in the rules governing remote control and general operation of repeaters. The indications are quite strong that the relaxation may come, but not until repeater designers and builders prove beyond doubt that effective, failsafe, and adequate measures for autocontrol and subcontrol (tone access) can be demonstrated.

The need for monitoring from a fixed UHF facility has been challenged by amateurs and defended by the FCC. Commission spokesmen say they will not even consider allowing unmonitored repeaters, or control from a mobile, until a positive means can be shown for providing certain, reliable control under all operating conditions. Tone-access repeaters with backup timers for passive control are a giant step toward meeting this goal.

Ed. Note. A series of three articles describing tone generators and decoders appeared in 73 Magazine, Feb 1970. The series includes "Encoders for Subaudible, Tone-Burst, or Whistle-On Use," by John Gallegos (W6ZCL), "Tone Decoders for Remote Switching Applications," by Ken Sessions (K6MVH), and "Setting Up the Tone-Burst System," by Les Cobb (W6TEE). The reader is referred to this series for encoder and decoder circuits and for installing tone units into user transmitters.

...K6MVH ■

SIMPLE REGULATED POWER SOURCE FOR ICs

Integrated circuits and some transistor units require low supply voltages at relatively high currents. While dry cells can meet the requirement temporarily, serious work and finished units are conveniently fed with line-operated supplies. The usual answer is a transistor regulated supply often more complex than the device it feeds.

The circuit shown in Fig. I was designed to supply an IC logic section of a business machine. It would make a compact low-cost supply for an IC keyer or for general experimental work.

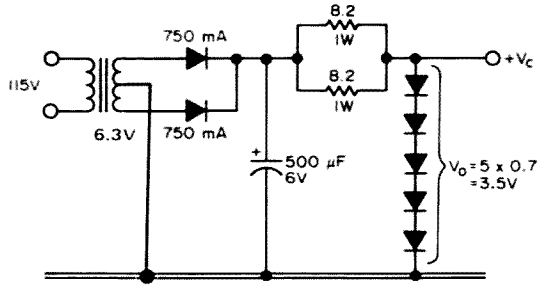


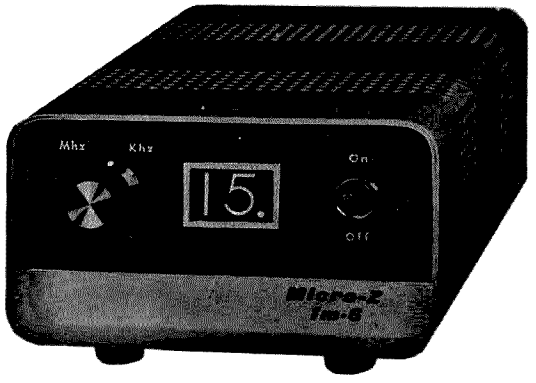
Fig. 1. Simple regulated power source for IC s.

Basically, it takes advantage of the 700 mV forward voltage drop of silicon diodes which varies only slightly with current change. A little time spent selecting individual diodes can provide a regulator for the exact voltage desired, including those values for which standard zeners are not available. Best of all, it can be assembled from parts commonly lying idle, thus freeing the regular bench supply for more demanding work.

The 4.1Ω limiting resistance provides short-circuit protection for the 750 mA rectifiers, and is a necessary part of the filter circuit. A load current variation from 0 to 50 mA causes a supply drop of just 1.65%. To improve regulation at higher currents, increase the size of the filter capacitor.

Edward L. Raub, Jr. W1RAN

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A SOLID-STATE 10-MINUTE TIMER

Walt Pinner WB4MYL
7304 Lorenzo Lane
Louisville KY 40228

This 10-minute solid-state station timer is a simple economical, one-evening project whose application is only governed by your imagination. An indicator is illuminated by a *set* button and burns for 10 minutes before extinguishing, thereby reminding you longwinded ragchewers or break-in operators to identify as required by the FCC. The unit, made up of 11 components, is installed inside my SB-100 transceiver with the indicator lamp located behind the main tuning dial, where it is readily visible (eliminating the need for hole drilling).

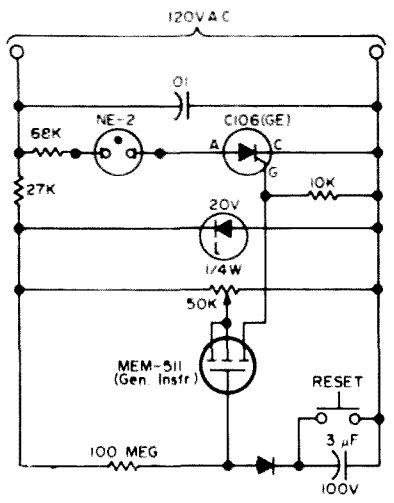


Fig. 1. Schematic diagram of the MOSFET 10-minute timer.

As shown in the circuit diagram (Fig. 1), the heart of the unit is a MOSFET which gates an inexpensive SCR to turn on an indicator lamp (or, if you prefer, energize a relay). Voltage pulses are applied to the transistor and the RC timing circuit, 100 MΩ low-leakage diode, and a 3 μF 100V capacitor.

When 6V appears at the capacitor, the FET is turned off, turning off the SCR and the indicator lamp. Pressing the *set* switch discharges the capacitor, recycling the circuit for an additional 10 minutes.

Because the circuit is line-operated, all components should be isolated from the chassis. In view of the high impedances

involved do not attempt to measure voltages, as any but the most sophisticated test equipment will load the circuit.

Caution . . . The FET is supplied with a shorting wire around its leads; this should remain in place until the transistor is soldered in the circuit.

Precise timing is adjusted with the 50 kΩ pot, which will compensate for component tolerances. Any neon panel indicator with a built-in resistor can be used in place of the NE-2 and 68 kΩ resistor. Color the bulb to contrast with existing panel lighting. Should you wish to power other dc loads up to 2A merely substitute your choice for the lamp. For loads in excess of 2A, the NE-2 may be replaced by a 115V ac relay with a series 600Ω 10W resistor and filter (Fig. 2).

The 600Ω resistor limits the direct current through the ac relay to a safe level, and the 20 μF capacitor insures that the relay will remain on during the half-cycle the SCR is off. The reset switch may be any unused contacts on your rig, such as spare positions on your 100 kHz calibrator switch. It may also be convenient to replace a control with one having a pull switch, thus eliminating the need for hole-drilling should you wish to preserve the original appearance of your equipment.

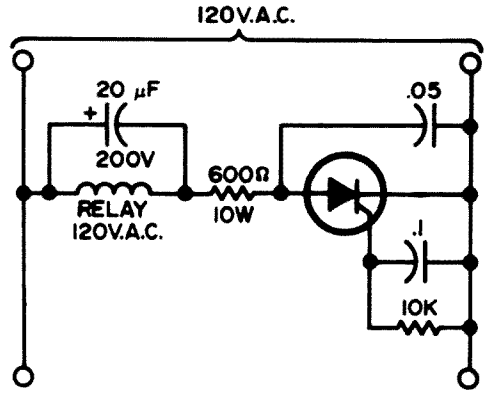


Fig. 2. A relay and associated filter network may be used as shown for switching loads in excess of 2A.

Wiring is not critical and a circuit board (full size) is shown Fig. 3. After soldering, it is suggested that all connections on the board be cleaned with a solvent such as nail polish remover to eliminate leakage via flux, etc. The zener and low-leakage diode were obtained from surplus boards. The SCR is not critical, and any type with 120V ratings that will trigger at 0.8V is acceptable.

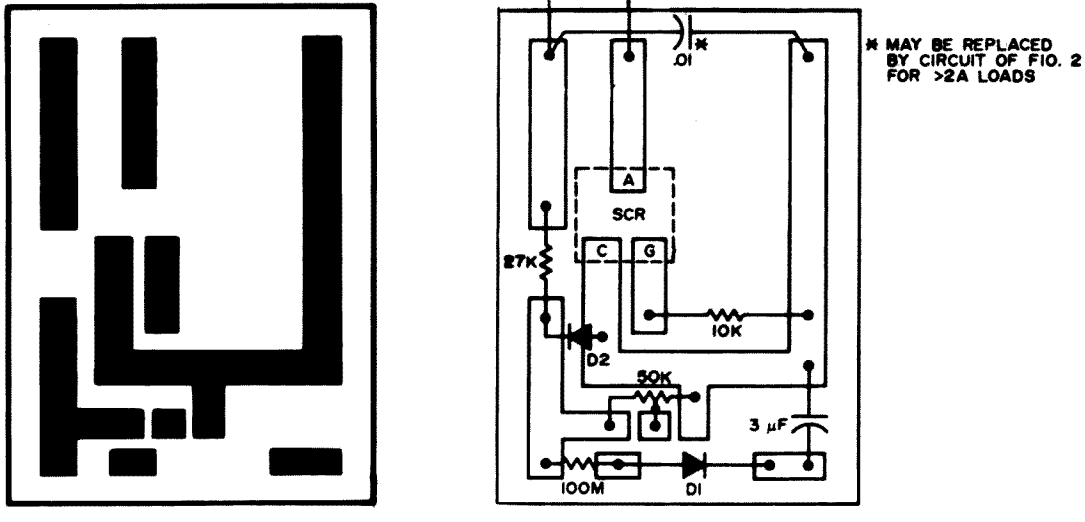
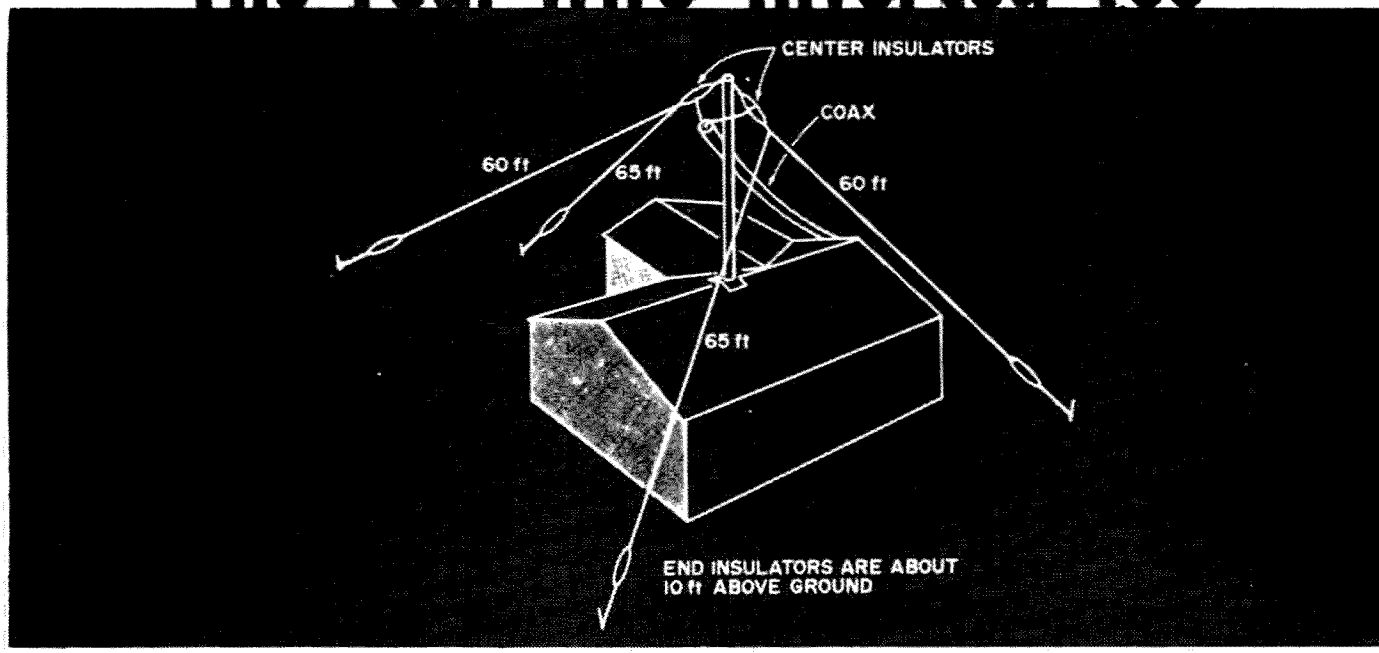


Fig. 3. Layout is shown actual-size alongside a composite view which gives component placement data.

. . . WB4MYL ■

William A. Brink WA6COB
415 Conestoga Way
San Jose CA 95123

The Four-Wire Inverted Vee



In a search for a better broadband antenna for 80 meters, I have devised one that works beautifully for me. Since it is possible that some of our readers might also be interested I will attempt to describe it to you.

I call this antenna the Four-Wire Inverted Vee, as that seems to best describe it. In the past I have used the conventional inverted vee on the lower bands with good results. This one seems to work better for me. Each side of the vee consists of two wires, one 60 ft long and one 65 ft long. This gives me one conductor near resonance at the top of the band and one near resonance at the bottom of the band. The center of my antenna is about 35 ft above the roof of my house (on top of a 40 meter vertical) which gives me an overall height of about 50 ft.

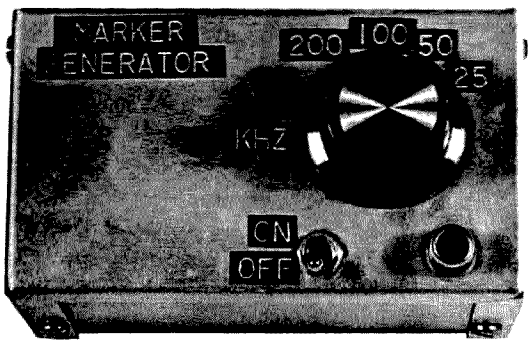
The best feature of this antenna is that it is coax fed with RG-11/U and tunes the whole band with a very low vswr. If it were fed with RG-8/U, the vswr might be even lower. Any rate, the highest vswr indication was 1.5:1 at 3.8 MHz. My measurements were all made with homebrew equipment that shows a good null on a Heath antenna. While the measurements are not precise due to the fact that 75Ω coax was used (rather than 50Ω), they are close enough to prove the effectiveness of the antenna system.

I have been using this antenna for the past six months and have achieved good results on both CW and RTTY. While I don't operate SSB since the funny license plan went into effect last year, I do want to point out that the antenna loads well in that portion of the band and should give the same results as at the bottom end. While I have not attempted to guess at the radiation pattern, I have worked a good many states on RTTY since I installed the Four-Wire Inverted Vee.

Frequency, MHz	Vswr with 50Ω bridge
3.5	1:1
3.6	1:1
3.7	1.35:1
3.8	1.5:1
3.3.9	1.22:1
4.0	1.22:1

William A. Brink WA6COB ■

AN IC MARKER GENERATOR



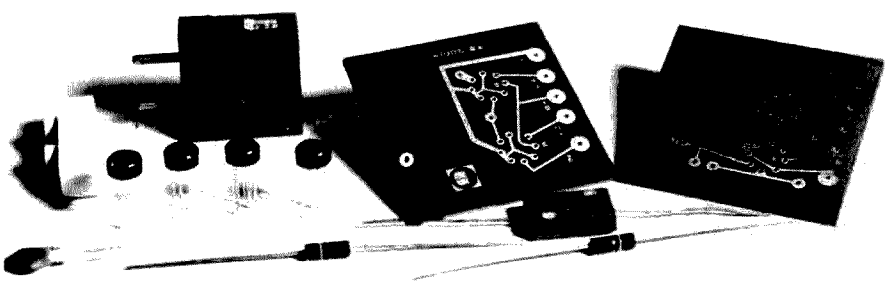
D.A. Poole K4BBC
1223 Brookwood Drive
Winston-Salem NC 27106

Simple IC device gives marker signal when you approach the edge of your authorized band.

The incentive licensing regulations have created a need for identifying restricted band segments. The easiest method of doing this is by using a crystal-controlled oscillator to provide marker signals at the edges of the subbands (getting the Extra license is another good approach).

The marker generator described here provides calibration signals at 200, 100, 50, and 25 kHz intervals, usable up through the 6 meter band. Although the basic components shown were purchased in a kit (R&R Electronics, December, 1969. 73 Magazine) containing the two circuit boards, the generator could be

R&R (311 E. South St., Indianapolis IN 46225) supplies all components and PC boards in kit form.



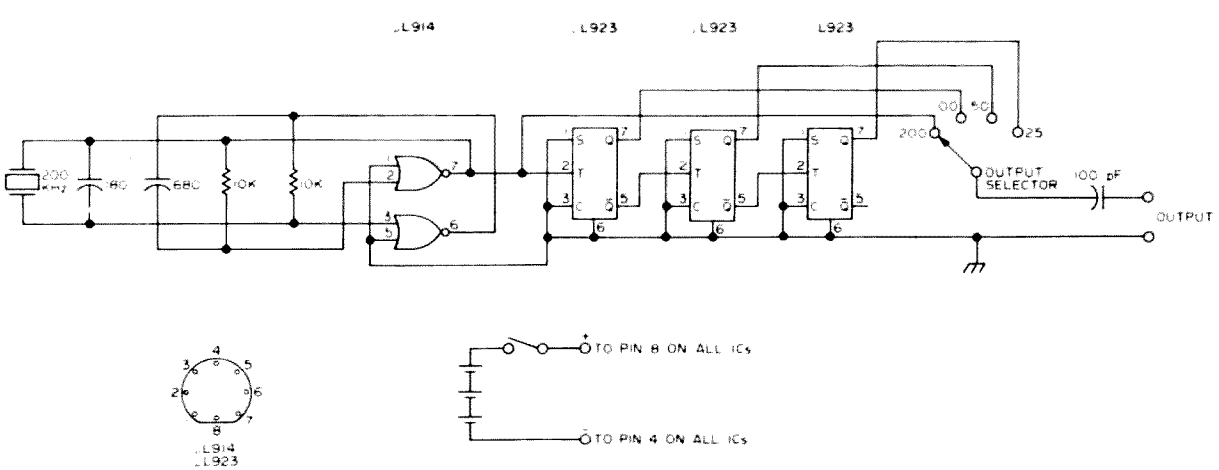
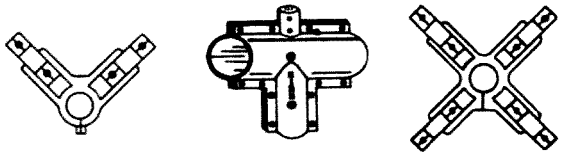


Fig. 1. IC interconnection and base diagram for the band-edge marker generator.

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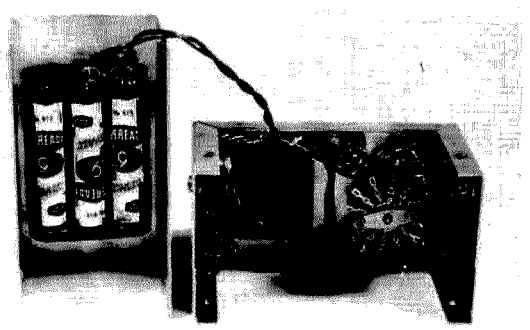
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built on perforated board from individually purchased components.

The circuitry consists of a 200 kHz oscillator and three divide-by-two stages. In the oscillator, a Fairchild μL 914 integrated circuit is connected as a crystal-controlled multivibrator. A 200 kHz crystal is used because it is cheaper and more stable than the 100 kHz crystals usually used in marker generators. With the values shown the frequency is within a few cycles of zero-beat with WWV.

The output from the 200 kHz oscillator is successively fed to three μL 923 integrated circuits, each connected to divide the frequency by two. A rotary switch selects the desired output. Three penlight cells supply the 4.5V required by the integrated circuits.

The generator in the photo was built in a 4 x 2¼ x 2¼ in. aluminum box. The printed circuit boards with integrated circuits are attached to the box with screws and small spacers. The small rotary



The finished marker generator. Note that penlight cells mount handily in cover section of minibox.

switch, battery holder, and output jack are from Lafayette.

The generator has proved to be reliable and stable, providing subband identification at a flick of the switch. Because the harmonic output of the divider is quite strong, tight coupling to the receiver or transceiver is not necessary. Good results can usually be obtained by slipping the end of the output wire down into the shield of the first rf amplifier tube.

. . . K4BBC ■

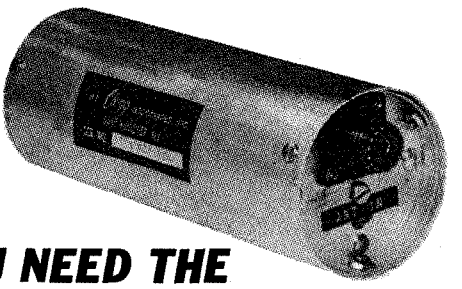
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IMPROVING REGULATION IN HIGH VOLTAGE SUPPLIES

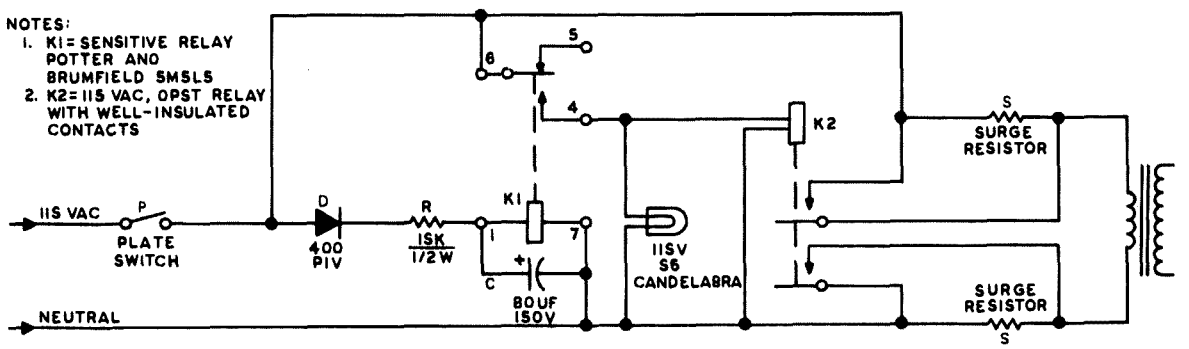
Some improvement in the regulation of a high voltage semiconductor power supply system with capacitor input can be obtained by shorting out the protective surge resistors placed in the secondary leads of the power transformer by means of a delay circuit. The amount of improvement, naturally, depends on the values of the resistors.

One method of accomplishing this objective is shown in the diagram.

When the plate switch in the primary of the high-voltage transformer is closed, the RC time constant provides a delay of about one second before the contacts of relay K2 close and short the surge resistors. Variation in delay from milliseconds to several seconds can be achieved by choosing values of R between 10 and 20 kΩ and/or substituting different values of C.

Since the time constant in the filter circuit of the power supply is so small, a delay of one second is sufficient to provide ample protection in shorting out the surge resistors when the power is turned on. A 115V isolating transformer must be used between the plate switch and the diode if the 115V line polarity is not observed.

Louis Berman K6BW ■



STUDY GUIDE GENERAL CLASS LICENSE

PART III

And more power to you.

It may seem that we're putting too much emphasis, in this study course for the General license examination, on the ultrabasic fundamentals of electricity and electronics. After all, nearly three-quarters of all the questions on the FCC's official "study list" deal with matters much more complex than those we have been examining since we began.

However, our stress on the ultrabasics is deliberate. With a strong understanding of the major principles of electrical physics as a foundation, the more specialized matters met on the actual examination will be much more solidly seen. In other words, we're going a bit slowly at the beginning, so that we can do a better job later on and make it all appear to be as simple as it really is.

Already covered has been the propagation of electromagnetic energy, through both wires and space, as well as the ideas of voltage and current, resistance and reactance, and Ohm's Law for both ac and dc. We're now ready to attack such puzzlers as power, decibels, and harmonic frequencies.

Specifically, this time we're going to look at the following three questions from the FCC study list (the numbers are those appearing on the official list):

15. What is a decibel?

16. What is a harmonic? List ways of minimizing harmonic generation in frequency doublers, vacuum-tube amplifiers, transmission lines, and antennas.

30. Define instantaneous power, average power, sideband power, audio power, and peak envelope power. How is each related to the voltage and current that produced it? How is each related to the unmodulated carrier power?

Most of the questions that appear on the official study list are extremely specific ones dealing with some narrow aspect of a general subject, and to provide you a broader base of knowledge we have followed the practice of rephrasing the questions into more general forms.

This time, we'll do that with two of them – but one is already about as general as it can get.

Our questions, therefore, will be a mixture of our own rephrasings, and the study list question which is already general. We'll start by asking "What is Power?", which will build us a bridge from what we already know about energy, voltage, and current, to the many ways in which power can be specified. We'll follow that up by learning "How is Power Measured?" to determine how the various kinds of measurement and specification of power relate to each other. Next, we'll find an answer to "What is a Decibel?" – and in the process we may be able to remove some of the traditional confusion which always seems to surround this subject.

We will then direct our attention to harmonics, asking first "What Are Harmonics?" and then "How Can Harmonics Be Controlled?" By the time we complete our look at these, you should know more than you really wanted to about the subject.

What is Power?

"Power" is one of those words we all *think* we know the meaning of – and because of this, it's extremely important that we be sure right at the start of our studies of electrical power that we're all using the *same* meaning for the word.

Dictionaries list many meanings for power. In everyday conversation, we speak of political power and powerful motors, of the power of public opinion, and the power of the individual. There's the power we get from the wall plug, and the power to keep going we get from our food. All of these are different kinds of power.

So let's ignore what we think we know about the meaning of the word, and develop a brand new definition to use during our examination of this subject. Let's begin by going back to what we learned in the first chapter of this course, about current and voltage.

There, you may remember, we found out what "current" and "voltage" were by relating them to the two kinds of energy involved in the magnetic field and the electric field. We found that either of these two kinds of energy ("actual energy" and "potential energy") could apparently exist indefinitely by itself so long as nothing moved, but that as soon as "motion" came into the situation the total energy present began changing from one form to the other, and that this change of form of the energy was what we know as "electric" and "magnetic" effects.

While we didn't bring it out in so many words at that time, "motion" itself involved the use of energy – which might mean that putting motion into our balanced situation simply unbalances it by adding additional energy. This is one of the areas in which physicists are still uncertain as to exactly what goes on, but the assumption appears reasonable in view of the current belief that everything in existence is either energy, or equivalent to energy, and that the total amount of energy in the universe cannot increase or decrease but must remain forever unchanging.

What all of this means to us at this point in our studies is simply that any use of electricity involves a use of energy.

We also found, earlier, that resistance in a circuit causes some of the electrical energy present to be dissipated in the form of heat – which, again, is another kind of energy. If it won't cause too much confusion, we can consider that electrical energy which is changed to heat energy has been "used up"; we do not mean by this that it's no longer energy, but merely that it's no longer in the right form to be used electrically. In contrast, electrical energy which has been "locked up" by a change of phase relationships in an ac signal is not used up, because we can easily get to it again by changing the phase relationships back again.

When we do anything at all to electrical energy by means of our circuits, we must "use up" at least a part of that energy. Some of the energy we "use up" is wasted – that is, it doesn't do anything effective for us. If the circuit is operating properly, though, most of the energy "used up" will be used in doing what we want the circuit to do.

For example, the whole purpose of a radio transmitter is to transmit information to one or more other locations by radiating radio energy from the antenna. The energy which we radiate is "used up" so far as the transmitter is concerned; we don't get it back to use again, but must continue to supply more energy in the form of the operating voltages which keep the rig going.

Whenever we use up energy in this manner, it's convenient to be able to determine how much we are using at any specific time, as well as to know how much we have used since we began to use it.

Now we get back to our immediate subject, power. "Power," as it applies to electricity, is simply the rate at which electrical energy is used. This is *not* the same as the amount of energy used, any more than "miles per hour" is the same as "distance." The power measures only the *rate* of energy use.

Back in the first chapter, we learned that voltage is a measure of electrical pressure or potential, while "charge" is a measure of the actual amount of energy at any instant. "Current" is a measure of the *rate* of "charge," and so "power," which is the rate of energy usage, must be related to both "voltage" and "current."

And the formula for determining power is simple: power equals voltage times current. If potential is in volts and current is

in amperes, the resulting power will be in the unit of power, "watts" (for James Watt, inventor of the steam engine).

In physics, of which electronics is a branch, "power" is the same kind of thing as "work," and conversion factors exist which enable us to convert units of power into units of work. For instance, 746 watts equals 1 horsepower.

Notice that because power is a measurement of rate, like "miles per hour," rather than an absolute measurement such as "distance," it tells us nothing about the *total* amount of energy used. Just as the question "Which goes farther, a bicycle moving at 10 mph or an airplane doing 500 mph?" cannot be answered until the time of travel of each is known (if the bicycle goes for 72 hours while the airplane goes for only half an hour, the bicycle will go nearly three times as far), neither can the question "Which uses more energy, a 5W transmitter or a 50 kW transmitter?" be answered until the time during which each is operated is known. The 5W transmitter must operate 10,000 times as long as the 50 kW one to use the same amount of energy – but if it operates more than 10,000 times as long, it will use more!

To measure total energy consumption, we use such units as the kilowatt-hour or the watt-second. One kilowatt-hour is the amount of energy used by a 1 kW device in one hour, or a 1W device in 1000 hours, or any other combination which multiplies out the same way when power in kilowatts (thousands of watts) is multiplied by time in hours. Similarly, a watt-second is the amount of energy used by a 1W load in one second, or simply power in watts multiplied by time in seconds. The watt-second is also known as the "joule," after the physicist who first stated many of the fundamental ideas about energy and power, and is the standard unit of electrical energy usage. In practice, power companies charge for their product by the kilowatt-hour while photographers rate their strobe-light energy storage capabilities in watt-seconds or joules, and radio operators seldom worry about either since they are more concerned with the rate of energy use than with the total amount used.

How is Power Measured?

We've just met one way in which power is measured – in "watts." And we have learned that 1W is the rate at which energy is used in a circuit which operates at a potential of 1V and requires an energy flow of 1A. We also met the "kilowatt," which is 1000W. Now let's look at some of the other measurements of power.

Suppose for a start that we wanted to know how much power was required by a circuit operating at 100V dc, but that for some reason we had no ammeter with which to measure its current. We do know, however, that its resistance is 250Ω.

We can apply Ohm's Law using the known values of voltage and resistance to determine how much current flows. This tells us that current equals voltage divided by resistance, so we know that the current is 100/250 or 0.4A.

We can then plug this 0.4A figure into the power equation $P = EI$ to get power as 100V times 0.4A, or 40W.

For a shortcut, we can combine the equation of Ohm's Law that tells us $I = E/R$ with the power equation $P = EI$ by substituting the entire right-hand half of the Ohm's Law equation into the power formula in place of the I. This gives us a new power formula, $P = EE/R$. Since E times E is usually written as "E squared" (E^2), this gives us $P = E^2/R$, which defines power in watts as the square of the applied voltage, divided by the circuit resistance.

The same thing can be done if we know current and resistance but do not know voltage. In this case, we use Ohm's Law to determine voltage ($E = IR$) and substitute the "IR" from that equation in place of the "E" in the power formula to get $P = IIR$, or $P = I^2R$. That is, power dissipation in a circuit is equal to the square of the current, multiplied by the resistance.

The relation between power dissipation, current flow, and resistance which we have just developed is extremely important throughout electricity and electronics. It's the reason, for instance, that the power distribution circuits which carry ac power around the country from generating plants to the ultimate users operate at such high voltages. By using high voltage, current can

be kept comparatively low while transmitting the same amount of power. Keeping current low reduces the I^2R loss in the power lines, so more of the energy gets to the ultimate user and less goes to provide a foot-warmer for stray birds.

It's also the reason why a high-Q tank circuit in a ham transmitter may get hot enough to melt its plastic coil supports, even when there's apparently very little power going anywhere. A tank circuit with high Q has high circulating current, which may be measured in the hundreds of amperes, and the wire of the coil has a definite minimum resistance. If circulating current is 100 amperes and coil wire resistance is only 0.01 ohm, the I^2R power dissipated in the wire is still 100 x 100 x 0.01 or 100W. And a hundred watts worth of heat is quite a bit; if you don't think so, touch a 100W light bulb after it's been on for an hour, or maybe the tip of a 100W soldering iron.

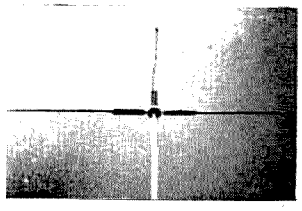
The three major ways of determining power in watts, then, are by multiplying voltage and current ($P = EI$), by relating voltage and resistance ($P = E^2/R$), and by relating current and resistance ($P = I^2R$). These equations, like Ohm's Law, work for all dc circuits, and for resistive ac circuits with certain restrictions.

The major restriction upon use of these equations with ac circuits involves the *units* of measurement to be used. With dc, a watt equals the power of a volt at a current of one ampere. When ac is introduced, the "voltage" and current are always changing – and this means that the "watt" becomes open to confusion unless we restrict things.

Even if we follow the conventional engineering standard and ignore all ac except the kind which has a sine waveform, both the current and the voltage are continually varying from a negative peak value through zero to a positive peak value and back again. To get a "power" calculation, we must choose which of these unlimited voltage and current levels to use.

While we might at first be tempted to use the "peak" levels, if we did we would find that "volts times amperes" would give us a figure that represented more power

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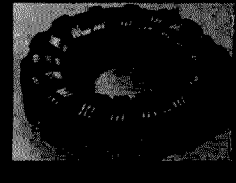
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than "volts times amperes" in a dc circuit does. In fact, the figure would be just twice as great as in a dc circuit.

This, of course, is not a happy state of affairs. A watt should be a watt, regardless of whether it's dissipated in ac or dc circuits.

If, instead of the "peak" levels, we use levels which will produce a "watts" figure just half as large, everything will come out as it should. But we cannot do this by using half the peak voltage and half the peak current, for that would give us half of a half, or one fourth, the power.

What we have to do is find a voltage level and a current level which multiply out properly. If we divide the peak value in each case by the square root of two, we will have such levels.

What's more, these levels turn out to be the "rms" or "effective" levels we have already met. In fact, the "rms" levels were chosen as the "normal" values for ac voltage and current specifically because they do provide power figures which are equal to those obtained with dc. Whenever ac power is mentioned, unless it's qualified with some sort of modifying word, what is meant is the power determined by multiplying rms voltage by rms current.

Another restriction on the determination of power in ac circuits comes from the fact that power can only be dissipated when voltage and current are in phase. That is, nothing but *resistance* can dissipate power. Ac circuits, however, normally contain reactance as well.

Reactance acts just as does resistance to limit voltage or current in the circuit – but this control is not achieved by dissipating the power into heat energy. Instead, the phase is altered. Since no power is dissipated by doing this, the effect cannot be expressed in "watts" or any other unit of power.

To cover such situations, the unit known as the "voltampere" was invented. Like power, it's obtained by multiplying rms volts times rms amperes, but it doesn't necessarily indicate any use of energy. If the circuit is composed of resistance only, its "voltampere" figure will be the same as its "power" figure; if reactance is present, there will be more "voltamperes" than "watts," and the difference between them indicates the amount of reactance. The ratio of "voltamperes" to "power" is known as the "power factor," and you may see it in the ratings for transformers or electric motors.

Now that we've seen how ac power is calculated and why the rms values of voltage and current are used, let's look at some of the modifiers often attached to the phrase – for instance, "average power."

This is a term most frequently used with respect to the power of an amplitude-modulated radio signal, and has nothing to do with "average voltage" or "average current." Instead, it's the average of the signal's rms power level, taken over several cycles of the modulating signal.

For this to make any sense, we must jump a little ahead of ourselves at this point and take a quick look at amplitude modulation (more exact discussions of modulation will come quite a bit later in this course). Figure 1 shows the

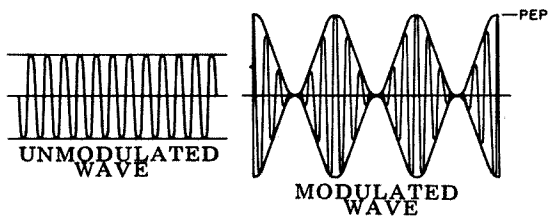


Fig. 1 Waveforms of unmodulated or "carrier" signal, and complete modulation envelope for 100% amplitude modulation are necessary to illustrate some of the various power measurements often encountered.Peak envelope power, for instance, is the power calculated from voltage and current at modulation peak, as indicated at right.

"envelope" waveforms of both a modulated and an unmodulated AM signal. You can see that the modulated waveform rises to higher peaks than does the unmodulated or "carrier" signal.

If the modulating signal is a sine wave, and if the maximum amount of modulation is applied as it is in Fig. 1, the total power of the modulated signal (averaged over several cycles of modulation) will be half again larger than that of the carrier. The "average power", then is 1.5 times

greater with such modulation than without.

"Instantaneous power," on the other hand, refers to the power figure that results from taking one specific instant during a cycle and multiplying the voltage at that instant by the current at the same instant. These are *not* rms values – the "instantaneous" values are used instead. If we choose the instant when both voltage and current are peak, the "instantaneous power" comes out to twice the "average power" – and in the modulated signal with its higher peaks, the maximum "instantaneous power" is four times as great as the carrier's "average power."

The maximum "instantaneous power" level possible for a modulated signal – that is, the instantaneous power at the peak of the modulation cycle – is called the "peak envelope power" or "PEP." This figure is often used to rate output power of SSB transmitters, and to compare the power levels of various types of modulation.

We have just noted that the average power of a fully modulated signal (if the modulation is itself a sine wave) is 1.5 times that of the carrier alone. The "extra" power is contained in the sidebands which are produced by modulation, and so is known as "sideband power." From this, we can say that "average power" of a modulated signal of any kind is equal to the "carrier power" plus the "sideband power."

"Audio power" is that power at audio frequency which furnishes, either directly or indirectly, the sideband power. If plate modulation is used, audio power and sideband power will be approximately the same number of watts (the only difference is that caused by the fact that the modulation process cannot be 100% efficient). The difference between the two in this case is that "audio power" exists as an af signal, while "sideband power" is at radio frequency.

All of these various kinds of power are related directly to the voltage and current which produce them, and all except instantaneous power and PEP are the product of rms voltage times rms current. Their relation to the "carrier" power level varies with the waveform of the modulating signal and the particular kind of modulation technique employed, and we'll go into that more deeply when we get to modulation.

When we attempt to measure the power involved in an ac signal which is *not* a sine wave, we have a problem. While it's theoretically possible (as we shall soon see) to analyze *any* ac waveform into a combination of sine waves, this is not a practical approach to power measurements.

The most accurate way to measure the power content of a non-sine-wave ac signal is to dissipate the power into heat by means of a suitable resistor, and use a thermometer to measure how much heat it produces. From this, we can determine the power figure by converting degrees-of-heat-rise to calories, and calories to watts.

Such an instrument is known as a "bolometer," and is often used in microwave work to measure the power of pulsed signals.

If the departure from a sine waveform is not extreme, many persons simply calculate peak instantaneous power from the voltages and currents as displayed on a scope, and divide that by two to get approximate rms power. Accuracy of this method depends on just how close to a sine wave the signal happens to be. For voice signals, it's not too accurate – but the error is such as to make you believe you have more power than is really present, so it turns out to be simply a safety factor in practice.

What is a Decibel?

Contrary to what you may believe or have heard, the decibel (abbreviated "dB" and often pronounced "dee bee") was *not* invented solely for the purpose of making an already complex situation more confusing. In fact, the whole idea behind the decibel was to make things simpler!

And once decibels are adequately understood, they do simplify matters. The problem is like that of making friends with a porcupine; no matter which direction you approach from, it's only too easy to get stabbed unexpectedly by something painful.

Most textbooks approach decibels from a mathematical viewpoint, which isn't such a bad idea, except that you don't really have to comprehend the math behind them in order to make good use of them. We'll try another approach.

In many situations involving a comparison between two values of the same quantity – such as the amount of light present in a room, or the intensity of sound produced by a PA system – it's not so much the *absolute* difference between the values that's important, as the *ratio* between them.

That is, you wouldn't compare the brightness of two different light bulbs by saying that one was "25 watts more powerful" than the other. Instead, you would say that it was "twice as bright."

If one bulb was a 25-watter and the other rated at 50 watts, you might expect twice the brightness from the doubling of power, but you wouldn't expect to keep getting twice the brightness every time you went up another 25W in power.

Actually, the relation between brightness and wattage of the bulb isn't really all that simple and we don't mean to imply that it is. Our purpose is to bring out the difference between the *ratio* of "twice" or "double," and the *absolute* increase of 25W.

Musical tones offer another example. On most pianos, the note known as "middle C" has a frequency of approximately 512 Hz. The next higher C is about 1024 Hz, and the C above that is about 2048 Hz. The absolute values determine whether the tone is at the top or bottom of the keyboard's range, but the 2-to-1 ratio is what makes it a C rather than a B or a D.

Now we bring decibels back into the picture. All that the decibel amounts to is a unit for the measurement of power *ratio* rather than any absolute value. Any time power is doubled, it has been increased by 3 dB, no matter what the starting point. If the power is cut in half, it has been decreased by 3 dB.

While the decibel is the unit normally used in all technical work, it is not the "basic" unit. The basic unit of power ratio is the "bel," named for Alexander Graham Bell of AT&T renown, and it's defined as being a power ratio of 10:1. The "decibel" is one-tenth of a "bel" – but it's not a 1:1 ratio (the 1:1 ratio is zero bels or 0 dB). And right here is one of those porcupine quills.

The problem is that *ratio* itself involves multiplication or division. A 2:1 ratio implies multiplication or division by 2, a 10:1 ratio by 10, and so forth. The *units* of ratio, though, are not multiplied or divided, but instead are added or subtracted. a 10:1 ratio is 10 dB. A 100:1 ratio is not 10 *times* 10 dB or 100 dB, but rather is 10 *plus* 10 dB or 20 dB.

If you're familiar with the mathematics of a log table or of exponents, you have probably realized by this point that the decibel behaves like the log of the true ratio. The bel, in fact, *is* the log of the power ratio, and since 10 dB equals 1 bel, the formula for calculating decibels becomes merely "10 times the log of the power ratio." If you have a log table handy, the ratio itself can be calculated by logs – but that's not required in order to make use of decibels, as we shall see shortly.

Strictly speaking, the bel and decibel are units for the measurement of *power* ratios and cannot be used for measuring anything else. This might appear to be rather confining until you recall that power is simply a measurement of the rate at which energy is used, so that whenever energy is actually being dissipated you have power whether you realize it or not.

The situation isn't helped any, though, by the fact that many people speak (incorrectly, as it happens) of "voltage decibels" and "current decibels."

These "voltage" and "current" decibels came into vogue because it's possible to calculate power when only voltage or current, and circuit resistance, are known. We saw this in the previous section of this installment, and developed a pair of "shortcut" equations by combining the power formula with the appropriate form of Ohm's Law.

Since decibels are calculated by first getting the ratio between two power figures, then taking the log of that ratio

and multiplying by 10, it's possible to plug the "shortcut" power equations in place of the actual power figures, and come up with a corresponding pair of decibel equations which apparently compare voltages or currents. Both the shortcut power equations involve squaring the voltage or current figure, and when we move this into the decibel equation we do the squaring by multiplying by 20 rather than 10.

But what we have is still a *power* ratio, and in addition we have introduced a restriction that both voltage figures (or current) must be in circuits of identical resistance.

Since a 2:1 power ratio comes out to 3 dB and a 2:1 voltage ratio comes out as a 6 dB, people began calling the decibel values obtained from the composite equations "voltage" or "current" decibels and the belief grew that they were somehow different from "power" dB.

Actually, there's no difference between one set of dB and any other. The apparent difference is actually the difference between a power ratio and a voltage ratio.

If we double the voltage present across a resistor without changing the resistance value, the current through it must also double (Ohm's Law proves this). That means that when we figure the power, we must multiply twice the voltage times twice the current, and we come out with a power ratio of 4:1.

A power ratio of 4:1 comes out to be 6 dB, and a voltage ratio of 2:1 is also 6 dB. Since a 2:1 voltage ratio across the same resistance (which you recall is a requirement for using the "voltage decibel" equation) is the same as a 4:1 power ratio, you can see that there's no difference in the decibels themselves whether we get them by voltage/current calculations, or by power calculations.

If you're going to use log tables to deal with decibels, here are the two equations:

$$\text{decibels} = 10(\log \text{power}_1 - \log \text{power}_2)$$

$$\text{decibels} = 20(\log \text{voltage}_1 - \log \text{voltage}_2)$$

For current, use the "voltage" equation but substitute current in place of voltage. For either equation, the larger of the two quantities is always used as the first, so that the result will always be positive.

But you don't need to use a log table or a slide rule – or even know what they're all about – to figure out decibels accurately enough for all practical purposes. All you need to do is memorize a couple of facts and four specific decibel values.

We've already met the facts – they are that decibels add together, so that if you know a 10:1 ratio is 10 dB, you can figure out a 100:1 ratio as being 20 dB and 30 dB as being 1000:1. The process can continue as long as need be. Adding dB multiplies the ratio, and subtracting dB devides the ratio. If 100:1 is 20 dB and 2:1 is 3 dB, then 50:1 is 20–3 or 17 dB.

Now for the values. One decibel is 1.25:1, or 5:4. Three dB is 2:1; 5 dB is 3.16:1, and 10 dB is 10:1. From these, we can get any other values we may need by adding and subtracting. For instance, 9 dB is 3+3+3 dB, or 2x2x2 or 8:1.

From just these values, you can find out how many decibels any specific ratio amounts to, or conversely what ratio is meant if you have a known number of decibels, because you can build up any number you want by proper addition or subtraction of 1, 3, 5, and 10.

For instance, how many decibels stronger than a 25W transmitter is a 500W one? First, we convert the absolute power figures of 500W and 25W to a ratio by dividing 500 by 25, and discover that the ratio is 20:1. Next, we divide the 20 by 10 and note down the 10 dB effect of that division; the resulting ratio is 2:1. But a 2:1 ratio is 3 dB, so we add 3 dB to the 10 we already have, and the answer is 13 dB.

Let's try another one. Good operating practice requires that all spurious products from a single sideband transmitter be at least 35 dB below the power level of the transmitted sideband output. If we have an SSB rig with a PEP of 150W, how much power can we let out as "garbage" without violating these standards?

This time, let's take care of the odd 5 dB first. To do so, we divide our 150W PEP figure by the 5 dB ratio equivalent, 3.16, and come up with about 47.4W. This would be 5 dB below the PEP, but we want to be 35 dB below, so we still have 30 dB to go. But 30 dB is a 1000:1 ratio, so

dividing 47.4W by 1000 gives us the answer – 0.0474W, or a little less than 50 mW PEP of garbage would be permissible.

With this technique, you don't need a log table or a slide rule to be a decibel expert – and comparison of power levels is as simple as adding and subtracting.

One point deserves special mention here; the S-meters on many receivers are calibrated in both "S-units" and "decibels over S9," and most operators believe an "S-unit" equals 6 dB.

Actually, however, the "dB" indicated on S-meters bear little if any resemblance to true decibels. We'll prove it:

Most S-meters will indicate a signal that is supposed to be "60 dB over S9." That means a signal having one million times the power of one which produces an S9 reading, which would require one thousand times the voltage of an S9 signal at the receiver input terminals.

Most S-meters, also, are calibrated to read "S9" at an input signal level of 25, 50, or 100 mV.

That means the "60 over 9" signal, if it really *were* 60 dB over S9, would be at least 25V at the receiver input. If the antenna is connected to the receiver via 52Ω coax, that 25V level would amount to about 12W of rf power coming into the receiver. Many transmitters which won't put out 12W to their own antennas, however, will produce solid "60 over 9" signals on receivers several miles distant! If the S-meters were anything like accurate, this would mean that the signal had to *gain* power between the transmitter and the antenna – but in fact it loses power rather rapidly.

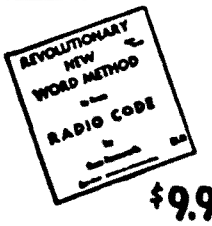
Had enough of decibels for now? Let's move on to another subject which also deals with ratio – but ratio of "frequency" rather than of "power" or "energy."

What Are Harmonics?

Back in the first chapter of this course we made the acquaintance of ac, and met one of the major characteristics of any ac signal – its frequency.

An ac signal may have any frequency greater than zero, although most common ac signals lie in the range from around 10

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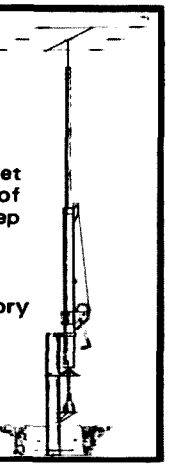
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or 15 Hz up to several thousand MHz. Physicists consider light itself as an ac signal of exceptionally high frequency (so high, in fact, that it's not normally measured in hertz at all), and for some purposes it turns out to be convenient to treat dc as being an ac signal with a frequency of zero.

Since an ac signal may have any frequency at all within this unimaginably wide range, it's only natural that some signals must have frequencies which are exact multiples of those of other signals. For instance, a 24 Hz signal is at two times the frequency of a 12 Hz one, or 3 times that of an 8 Hz signal, or 4 times a 6 Hz signal, and so forth.

We can go the other way, too. For instance, if we start with an 8 Hz signal, we could have signals at 2 times 8 or 16 Hz, 3 times 8 or 24, and so forth all the way up until we run out of numbers.

The point is that no matter what the frequency of the signal with which we start, other signals may exist at frequencies which are exact multiples of our original. As it happens, these other signals bear some special relationships to our original signal, and for this reason are known as the "harmonics" of the original (which is itself known as the "fundamental frequency" signal or merely "the fundamental").

One of the special relationships between a fundamental and its harmonics involves their mutual timing. If we start all the signals from zero at the same instant, then whenever the fundamental's voltage (or current) waveform crosses zero, so will that of each harmonic.

This is always true, because of the definition of a harmonic as "an exact multiple" of the fundamental frequency. If the frequency is two times that of the fundamental, then during the time that the fundamental goes through one half of its cycle and gets back to zero, the harmonic will complete a full cycle and reach zero at the same instant. When the fundamental has completed one full cycle, the harmonic has completed two, and again they reach zero together. The harmonic also goes through zero when the fundamental is at either peak – but we don't care about that right now.

If the harmonic frequency is three times that of the fundamental rather than twice, then when the fundamental is half-way through its cycle and reaches zero, the harmonic will have completed one full cycle and will be half-way through another one. At the end of a full cycle of the fundamental, the harmonic will have completed three cycles.

Harmonics are identified as second, third, and so forth, according to the multiplying factor involved. The second harmonic is at a frequency two times that of the fundamental, the third at three times fundamental frequency, and so on. The "order" of a harmonic usually refers to its separation from the fundamental; second, third, and fourth harmonics are often called "low-order," while fifth and higher are known as "high-order." The dividing line between "low" and "high" harmonics, though, depends largely on the particular problem under discussion.

The same arguments which we just applied to the second and third harmonics apply to all of higher order as well. Those which are at even multiples (even harmonics) of the fundamental will be completing a cycle when the fundamental reaches the midpoint of its cycle, and odd harmonics (those at odd-numbered multiples) will be in the middle of a cycle when the fundamental is at midpoint.

Because the timing relationship between a signal and its harmonics is made constant in this manner by the definition of harmonic, we can talk about "relative phase" between a signal and its harmonics although in general, "phase" and refer only to timing differences between two signals of identical frequency.

That is, an odd harmonic which is "in phase" with its fundamental crosses zero at the same time as the fundamental, and is going in the same direction (whether positive or negative).

The same signal "180 degrees out of phase" with its fundamental will still cross zero at the same instant as the fundamental every time, but will be always going toward opposite polarity.

If the two are "90 degrees out of phase" with each other, the harmonic will be at a peak value whenever the fundamental crosses zero. (See Fig. 2 for an illustration of these phase relationships between a signal and its third harmonic.)

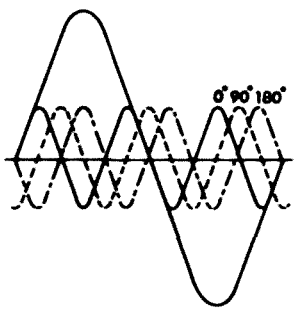


Fig. 2. Phase relationships between fundamental and odd harmonics are illustrated here using third harmonic. At 0 degrees, or in-phase condition, harmonic and fundamental both cross zero line at same time going in same direction. At 180 degrees, or opposite-phase condition, they cross in opposite directions. The 90-degree phase relationship is midway between these (dotted line).

The exact description of phase relationships between a signal and its harmonics depends to a large degree upon the order of the harmonic. Whether an even harmonic is "in phase" or "180 degrees out of phase" depends upon which half-cycle of fundamental you start from, as shown in Fig. 3 for the second harmonic.

Another special relationship between a signal and its harmonics involves the way in which they combine to produce signals which are not sine waves at all. Take, for example, a combination of fundamental and third harmonic such as that shown in Fig. 4.

When both these signals are present in a circuit which permits them to combine, the net energy at each instant is the total of the energy in both signals. At certain moments they add together, and at others they cancel; the result is the waveform shown by the heavy line in Fig. 4.

If we change the phase relationship between the two signals, the waveform changes, because the addition or cancellation occurs at different times.

Similarly, if we introduce still more harmonics into the mixture, we can produce far different waveforms.

When enough different harmonics are present, and with the phase of each being independent of all the rest, we can reproduce any ac signal at all. This is another reason why engineers deal only in sine waves although sine waveforms are rare in nature; any other signal may be treated as merely a combination of sine waves, each of appropriate phase and strength.

Even such decidedly non-sine waveforms as the square wave (Fig. 5C) can be built up from sine waves. Figure 4 showed the result of combining a fundamental and its third harmonic. Figure 5A shows what happens to this when the proper proportion of fifth harmonic is added, and Fig. 5B shows what happens when the first 100 odd harmonics are included; it's difficult to distinguish between the waveforms of Fig. 5B and Fig. 5C.

So now we have met the family of harmonics, and have seen that they are essential to most types of actual ac signals. Yet most discussion of harmonics centers upon methods of suppressing them, or preventing them in the first place. Why?

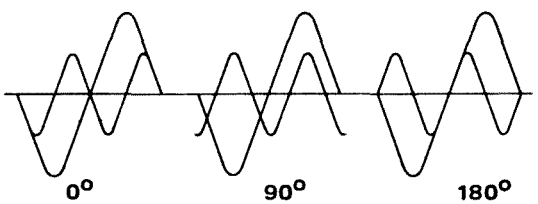


Fig. 3. Phase relation between fundamental and even harmonics (second is shown here) is a bit more confusing, since both the 0- (in-phase) and 180-degree relationships appear very similar.

A harmonic is good only if you want it. Like anything else, an unwanted harmonic or one which you cannot control is to be avoided whenever possible. FCC regulations prohibit transmission of excessive amounts of harmonic energy, and almost anything you can detect is considered to be "excessive." Yet we do make extensive use of harmonics in ham transmitters – always attempting to keep them under control.

Harmonics may be generated either deliberately or by accident, whenever a sine-wave signal is distorted by any means. If the signal was sine to begin with, and is not now, something must have been either added or taken away to make it different.

As it turns out, what was added was harmonic energy.

The distortion need not occur in an amplifier. *Any* action which distorts the signal will suffice. Most harmonic generation in ham transmitters, though, occurs in the amplifiers, because the "normal" rf power amplifier circuit distorts the signal greatly in the interests of handling high power with comparatively small tubes.

This distortion generates myriads of harmonics, because the waveform is very close to a square wave. All of them must be controlled. How to do so? That's our next subject.

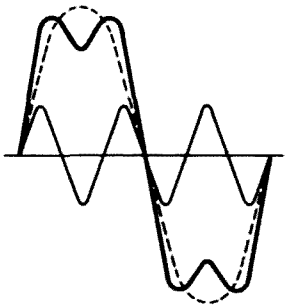


Fig. 4. Sine waves can be combined to produce any ac waveform. Combination of fundamental and third harmonic, shown here, produces tooth-shaped waveform (heavy line) which is first step toward square wave.

How Can Harmonics Be Controlled?

Now that we have met harmonics, and have seen that the only bad harmonic is one which we do not control, we're ready to try to find ways to control them effectively.

In general, harmonics can be controlled by either or both of two major routes. The first concentrates upon preventing their existence, while the second places the emphasis upon containing them so that they cannot escape.

Most practical situations require both types of control. The first, alone, is impractical and probably impossible as well, because all the efficient rf amplifier circuits capable of handling high power also generate harmonics prolifically. Without the first, the second becomes an unimaginably large job.

Both together, though, hold down the strength of the harmonics which are generated, and make them easier to bottle up.

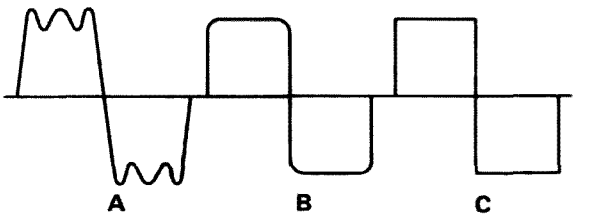


Fig. 5. Square wave can be considered as sine wave together with all its odd harmonics in proper proportions. At left (A) is result when fundamental, third, and fifth harmonics are mixed. Center (B) shows waveform when first 100 odd harmonics are included. Idealized square wave (C) is difficult to distinguish from version produced by first 100 odd harmonics; few scopes would be capable of telling which is which.

To find out how to keep harmonics from coming into existence, let's turn things around and see what we do to encourage harmonics whenever we deliberately want them (because most transmitters do make deliberate use of harmonics, in order to get improved frequency stability).

Deliberate harmonic generation is usually accomplished by circuits known as "frequency multipliers," which look like any other rf amplifiers so far as the schematics are concerned. What makes one generate harmonics for us is the specific manner in which it is operated.

To get a good harmonic generator, we bias the tube's grid much more strongly than for normal amplification, so that its switching action becomes more abrupt; then we apply much more driving power than normal to the stage, again to make the switching as rapid as possible and the output waveform as close to square as we can get.

When we do this, the tube's output signal has a high percentage of harmonic energy, and it's a simple matter to pick off the one we want with a selective (high-Q) resonant circuit. Usually, we take either the second or the third, because it's difficult to get enough power at higher multiples in a single stage. VHF transmitters often use an 8.3 MHz crystal followed by a tripler to 25 MHz and a doubler to 50 MHz, before beginning real power amplification.

Now if we want to generate as *few* harmonics as possible, all we need do is

reverse this philosophy. We take special care to bias the tube only enough to get the job done, and to keep driving power at the lowest level capable of producing proper output. The output will then be as free of harmonics as we can get – but they're still present, so our job is not yet done.

If we increase the Q of our resonant output circuit, we will make it more selective and it can reject the harmonics more efficiently. This will reduce the harmonic level at the antenna. In an rf circuit, we can raise Q by increasing the capacitance and then reducing inductance to keep the circuit resonant. Most of the effective resistance of the circuit is in the coil, and so when we reduce inductance we reduce resistance as well. The resistance decreases more rapidly than the reactance, and Q goes up accordingly.

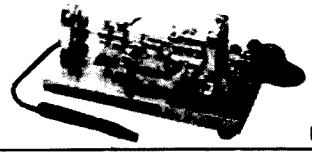
When we have reduced harmonics to the practical minimum by applying these ideas to all straight-through (input and output at same frequency) amplifier stages in a transmitter, we have almost exhausted the possibilities of the first method of harmonic control and it's time to turn our attention to the second – that of bottling up the remaining harmonic energy so that it cannot escape to cause trouble elsewhere.

Before we do so, though, one point needs special emphasis and a couple of tricks with harmonic generators deserve mention.

The point which we must emphasize is that a harmonic cannot be *generated* by anything which does not introduce distortion into the signal, but that the *radiation* of a harmonic can be suppressed by non-distorting devices.

In particular, neither a feedline nor an antenna can generate harmonics if it is in decent working condition; about the only thing in either which could *generate* a harmonic would be a corroded connection. However, if a harmonic is generated back in the transmitter, the feedline and the antenna can easily radiate it to the world – or just as easily can help you keep it contained.

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Now for the harmonic-generator tricks. When we use a harmonic generator to double or triple a frequency, we want a single specific harmonic and we don't want any others if we can help it.

As it happens, there's a special type of circuit which can generate even harmonics but suppresses odd ones, and another circuit which generates odd harmonics and cancels out the even ones. Use of these circuits makes life much easier, because the selectivity of the output circuits doesn't have to do so much of the selection job.

The even-harmonic generator is usually called a "push-push" doubler and the schematic appears as Fig. 6. Here's how it works:

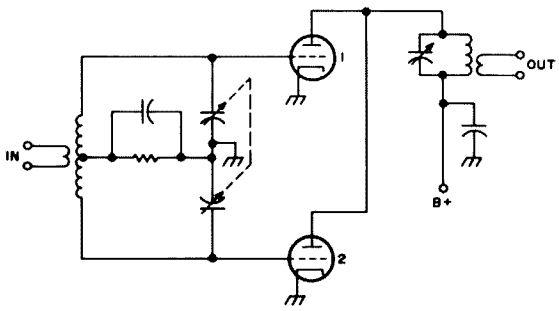


Fig. 6. This circuit, known as "push-push" multiplier, generates only even harmonics of input signal and cancels out fundamental and all odd harmonics.

The centertapped grid circuit divides the input signal into two independent signals, identical in strength but opposite in phase, and applies each to its own amplifier tube. Operating conditions for both amplifier tubes are made identical by the common grid resistance. Outputs at the plates of these tubes will be 180 degrees out of phase with each other at fundamental frequency, but the bias is chosen so that each output also contains an appreciable amount of second-harmonic energy.

These second-harmonic signals are in phase with each other (Fig. 7) despite the out-of-phase condition of the two halves of the fundamental signal.

When both plates are connected, in parallel, to the same tuned circuit, the fundamental portion of the output signal cancels itself out. No such cancellation occurs, however, for the second (or any

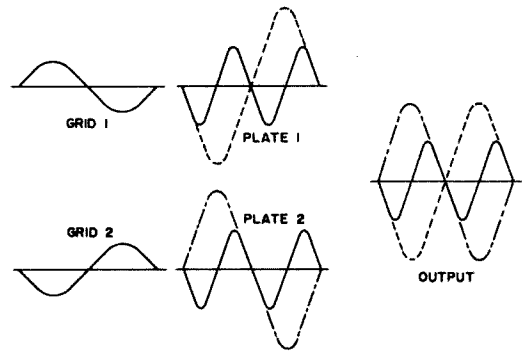


Fig. 7. Input and output waveforms show how push-push doubler works. Grid waveforms, at fundamental frequency, are equal in strength but opposite in phase. Same waveform, only amplified and reversed in phase, appears at plates of tubes – together with second-harmonic component introduced by tube's operating conditions. In output circuit, the two fundamental waveforms cancel each other out, leaving only the second harmonic.

even) harmonic, so by tuning the output circuit to the desired frequency we can recover the even-harmonic energy and couple it out to a later stage.

All odd harmonics are canceled, just as was the fundamental, because they are effectively 180 degrees out of phase with each other at the output.

If we want the odd rather than the even harmonics, a minor modification to the circuit as shown in Fig. 8 does the trick.

The input and amplification action is the same as in the "push-push" circuit. However, rather than the plates being connected in parallel, they are connected to the opposite ends of a "split" circuit which reverses the action of the input circuit, to combine the out-of-phase halves of the signal into a single, in-phase, output.

The recombination is accomplished by effectively reversing the phase of signals from one side, and leaving those from the other alone. This means that the previously in-phase even harmonics are now out of phase with each other, while the out-of-phase fundamental and odd harmonics are pulled into phase.

This circuit is known as the "push-pull" amplifier, because the phase relationships make it appear that half the circuit is "pushing" the signal while the other half is

"pulling" it and vice versa. It finds side use as a straight-through amplifier as well as a tripler, and always cancels out even harmonics without effect upon the odd harmonics or fundamental.

When we're trying to reduce harmonic generation to a minimum, use of either a push-push doubler or a push-pull tripler will help; either eliminates at least half the harmonics which might otherwise be generated in a frequency-multiplier stage.

Now let's move on to the other half of the harmonic-control situation and see how to bottle up or contain harmonics which we cannot avoid generating.

The starting point in containment of harmonics is to make it as difficult as possible for them to follow the normal signal-energy route. This means using enough tuned circuits in the normal path, and having adequate selectivity in each, so that harmonics will find it rough going.

To get selectivity we must have adequate "Q" in the resonant circuits. Attempting to get out the last particle of power by loading each stage to its limit or above is a sure way to reduce the Q of its tuned circuits, because Q is among other things a ratio of energy stored to energy released, and when we load a stage we force it to release energy. Harmonic output may skyrocket.

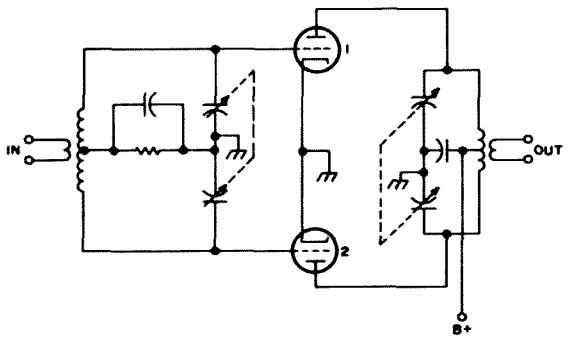


Fig. 8. Push-pull amplifier reverses action of push-push doubler to cancel out all even harmonics while amplifying fundamental or odd harmonics. If plate circuit is tuned to harmonic, it's a frequency multiplier, while if plate circuit is tuned to fundamental, it operates straight through.

Because tuned circuits cost money, and add additional controls which must be adjusted by the operator, many commercial rigs suffer a shortage of tuned circuits in the normal signal path.

We don't recommend redesigning equipment, but you don't have to. You can always add tuned circuits between the transmitter and the antenna by using an antenna tuner, despite the fact that many operators manage to radiate some sort of signal without one.

Another way of keeping down the harmonic output by containment is to be certain the feedline and antenna are well matched to each other, and that the feedline is properly grounded (if coax) or isolated (if open wire or twin lead) to prevent it from radiating on its own.

Proper antenna choice helps minimize harmonics. The popularity of "all-band" antennas helps us forget that any wire which works on 40 meters as well as it does on 80 cannot possibly help you reject the second harmonic of an 80-meter signal. Most "single band" antennas, on the other hand, have such high Q that they refuse to radiate signals at even harmonics of their band. They may perform nicely at odd harmonics, but the antenna tuner can easily take care of that by preventing the third harmonic from getting to the feedline.

When all these points have been covered, the only ways left for harmonic energy to get from the transmitter to the outside are by direct radiation from circuit components, and by conduction through wires which are not carrying the output signal (such as power leads, audio cables, etc.).

Direct radiation can be controlled by completely shielding the transmitter. If adequately done, this will make it impossible for rf to escape except by conduction on wires passing through the shield.

If we then add filters to each wire, to make certain that no energy travels in or on it except that which is supposed to be there, we can be fairly sure all harmonics are under control.

The filters may range from simple bypass capacitors on power lines, to complex arrangements of rf chokes, audio inductors, and capacitors, for lines which carry ac. Bypass capacitors often suffice.

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In fact, the normal legal requirements for control of harmonics are usually met without needing to shield and filter the equipment and its connections, but problems with television interference may make some shielding and filtering necessary.

We just mentioned filters – and that was getting ahead of ourselves by a fraction. In the next chapter, we'll go into filters and their action rather deeply, along with impedance matching and solid- state devices. . . . Staff ■

(Leaky Lines cont. from page 12)

ourselves out of business completely.

I want to tell you a little story. A very close and dear friend of mine owned a piece of property out on Long Island, and it had been in his family for generations. It was operated as a fish and game preserve where sportsmen could go and participate in their activities without any crowding or congestion. It was maintained by my friend through his own not inconsiderable resources, together with additional funds contributed by us, the others who used it. All of these were ardent conservationists, and all were fervent in their desire to preserve it and keep it from becoming just another fond, dead memory in a land in which such places are fast disappearing from the scene. All of us who used to wing shoot and angle there were quite convinced that we would succeed in protecting it from outside depredation. We felt that because we were doing what was clearly right, nobody would dream of changing things.

Then along came Mister Robert Moses, the former Parks Commissioner and high muckety-muck from New York City. He decided that this spot would make an ideal addition to the Parks System for the city. He filed for the property in the courts, and started official proceedings to take it over by what is called in law the "Right of Eminent Domain." My friend refused to sell, but in the end, he was literally forced to do so. Mr. Moses represented to the court that he needed to acquire it for the city so that it could be enjoyed by "all the people," instead of just an "aristocratic minority." And he succeeded in convincing the court that if private individuals were permitted to retain control, it would constitute a denial of the rights of the majority, and that this would be undemocratic. So, my friend was forced to relinguish ownership of a piece of prime land to the City of New York, and Mr. Moses lost no time in converting it to a recreational facility "for the people."

The duck blinds which used to line the river are now popcorn vendors, hotdog and pizza stands, and rest rooms. The herd of beautiful Japanese Sika deer has disappeared; so have the mallard, teal, and wood duck. The broad fields of millet and lespedeza which sheltered and fed pheasant and quail are now huge concrete and asphalt parking lots, where hundreds of cars and buses congest and pollute the air with their stinking exhaust fumes. The lovely little stream has literally become a cesspool, for those who bathe in it use it in precisely that fashion. The reverent silence which was unbroken save for the sounds of nature . . . birds, wind, rain, thunder . . . is now shattered by a maddening bedlam of transistor radios playing rock 'n roll, auto horns, screaming teenagers, loudmouthed and contemptuous misfits whose concept of the outdoors is concrete, steel, and glass. The grounds are strewn with fruit rinds, plastic containers, beer cans and bottles, discarded sundries made of liquid latex (the less said about which, the better.) In short, it

resembles the beach at Coney Island after a Fourth of July weekend. All in the name of "the people."

This happened because of one principal reason. The courts which swallowed Mr. Moses' grandiloquent plea in behalf of the "people" had absolutely no idea of the far deeper values of that place. They had never been shown. We all thought that they must surely understand the merits of our case by some natural instinct. We thought that anyone would tell the difference between right and wrong. We simply did not reckon with the awesome possibilities.

But nowadays, if Moses (or even Abraham or Isaac) were to try to pull a swindle like that, there would be an outraged outcry that would drown out the sound of Niagara. He would be swept away in the deluge of public indignation. Why? Because we have all been educated in the matter of pollution and conservation. Now we know that we must preserve the priceless heritage of our natural resources against those who seek constantly to exploit them for money, power, political gain, or even for the "people." There are far too many things in American life which have been utterly destroyed on the altar of forced collectivism, and if we are not alert to what is going on, we may find the same thing happening to amateur radio!

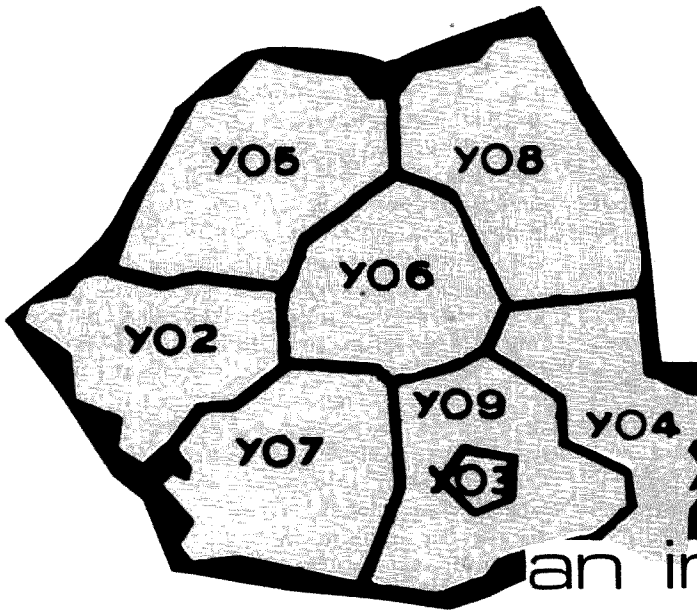
All the good intentions in the world cannot compensate for failure by default. Remember that old tale; For want of a nail the empire was lost? The feeble and impotent program of the League with respect to a real campaign of public relations is totally inadequate in representing and safeguarding the interests of almost 300,000 amateurs and the untold thousands yet to come. QST periodically (no pun intended) beats its tired tambourine about public relations. A photo is printed, showing one of our League functionaries posing with a mayor or chief of police or councilman, on the occasion of the unveiling of a bust of Guglielmo Marconi, or the first ham call license plates, or when some two meter hams coordinate the Split Lip, Kansas jug-blowing and Jew's harp tournament. Our activity is not a minor matter, to be treated like the grammar school spelling bee! Amateur radio is not a casual thing to be sloughed off so casually! Anyone who thinks it is, is just kidding himself. We have got to make sure that every legislator in this land is made familiar with the fuller and deeper significance of ham radio, than its use in controlling the floats in the Tournament of Roses, ski tournaments or boat regattas! We have got to make sure that the general public understands that in our ranks there reposes a nucleus of well-seasoned communications personnel, fully trained and equipped to assume vital obligations and duties, prepared to function in cases of national crisis and peril. We must educate Americans so that they will stop thinking of us (if they ever think of us at all) in terms of a bunch of hobbyists, playing around with toys and gadgets. We are not the same as model railroaders, antique collectors, mushroom pickers, bird watchers, weekend golf nuts, rug weavers, skin divers, folk singers, amateur plumbers, hikers or spelunkers! We are not scrabble players or spare time hypnotists and magicians. While we are certainly engaged in an activity which we enjoy, our interest is not a hobby! It is a *service!* And don't let anybody, but anybody, ever forget it!

The only way we can begin to do the job which needs doing, is to establish a properly functioning information office in Washington, D.C., with full-time people working at full time jobs, seeking influence in government circles, so that no one can throw a sneak punch while we're not looking. And make no mistake about it . . . there are many interests at this very moment, scheming and plotting, seeking ways in which to destroy our privilege, so they can get their hands on our frequencies, and use them for their own purposes. Any ham who feels secure about the amateur spectrum in today's dog-eat-dog world is either an ostrich or an imbecile! Any ham who would not be willing to bend all his energies and efforts toward insuring the future of amateur radio is either stupid or a scoundrel! And the exact same statement applies to any organization – let the chips fall where they may!

Before World War II, there were many voices which purred softly in our ears, "We don't have a thing to fear from abroad. Why should we waste all our money in order to arm ourselves against an attack which will never come? Our oceans will protect us." Does this sound familiar? Well, the folly of such short-sighted ideas was clearly comprehended, thankfully, and we were able to survive. We did not heed this siren song, chanted by doubletalkers who tried to lull us into a sense of false security, while plotting our destruction at the same time. I do not think that this comparison is at all far-fetched. We are being threatened at this very moment by forces which actively seek to curtail our privilege or limit it. If we do not summon up the will and moxie to fight against these groups, we may soon discover one fine day that we are beyond the point of no return. Then it will be too late to do anything about it.

Can we allow our most prestigious single organization to continue on its present blithe course, denying or minimizing the dire necessity for decisive action, while all of our competitors are consolidating their strength for a stab in the back? For to me, a CB lobby in Washington means only one thing . . . a grab for more frequencies at our expense!

Well, how about it? Isn't it high time and beyond, that every ARRL director and officer be bombarded with mail, instructing him to call for a change in the League's old approach to this vital question? I urge and entreat you to give this your most profound attention and consideration. It may be the very last chance we will ever have. Please think about it. 73. . .K2AGZ ■



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Romania, the YO land, is a beautiful country located in South Central Europe on the Black Sea, north of the Danube. It has wide plains, which are excellent for farming, sheep and cattle raising; hills with large vineyards; and the famous Carpathian Mountains covered with deep forests rich in coal, iron, gold, copper, and salt. The cities, growing industrial centers, have good schools and universities. Romania's oil fields and refineries are known worldwide, as is its nicest region: Transylvania.

Romania has eight amateur districts; from YO2 to YO9. Bucharest, the capital, is YO3. Its neighbors are HA, YU, LZ, UO5, and UB5. In YO-land amateurs are organized by the (Romanian Federation of Radio Amateurs) which maintains a large staff. Some of them are at the central headquarters in Bucharest, but most of them are in charge of the district radio clubs all over the country. The district radio clubs have their own councils which guide the activities of the rest of the clubs in the district, and the individual amateurs.

There are two basic forms of activity; the club and the individual station; co-operation between them is strong and useful for both. In YO-land there are a little over 1200 licensed radio amateurs.

The Club Stations

The club stations are easy to identify; they have a K after the number indicating the district. For example YO8KAN is a radio club in the city of Bacau. The Romanians, being very sociable, love to belong to a club. There they meet friends, operate the club station, do some work in the club's shop, read books or magazines in the library, get advice from the more experienced, or – this is very important – they can boast of the latest DX QSO or show around a rare QSL card.

The main tasks of the district radio clubs, which are financially supported by the government, are to guide, advice, teach, organize, and give material help to the other clubs and individual stations in the district.

The following district club stations, each having many operators, are very active on the air: YO2KAB in the important university city and industrial center of Timisoara, "the city of gardens"; YO3KSD in Bucharest, the modern capital of the YO-land, YO4KCA in Constantza, the famous port on the Black Sea; YO5KAU in Oradea, the city of hospitality, located in western Romania on the Tisza Plain; YO5KAI in Cluj, the capital of Transylvania, known for its very friendly

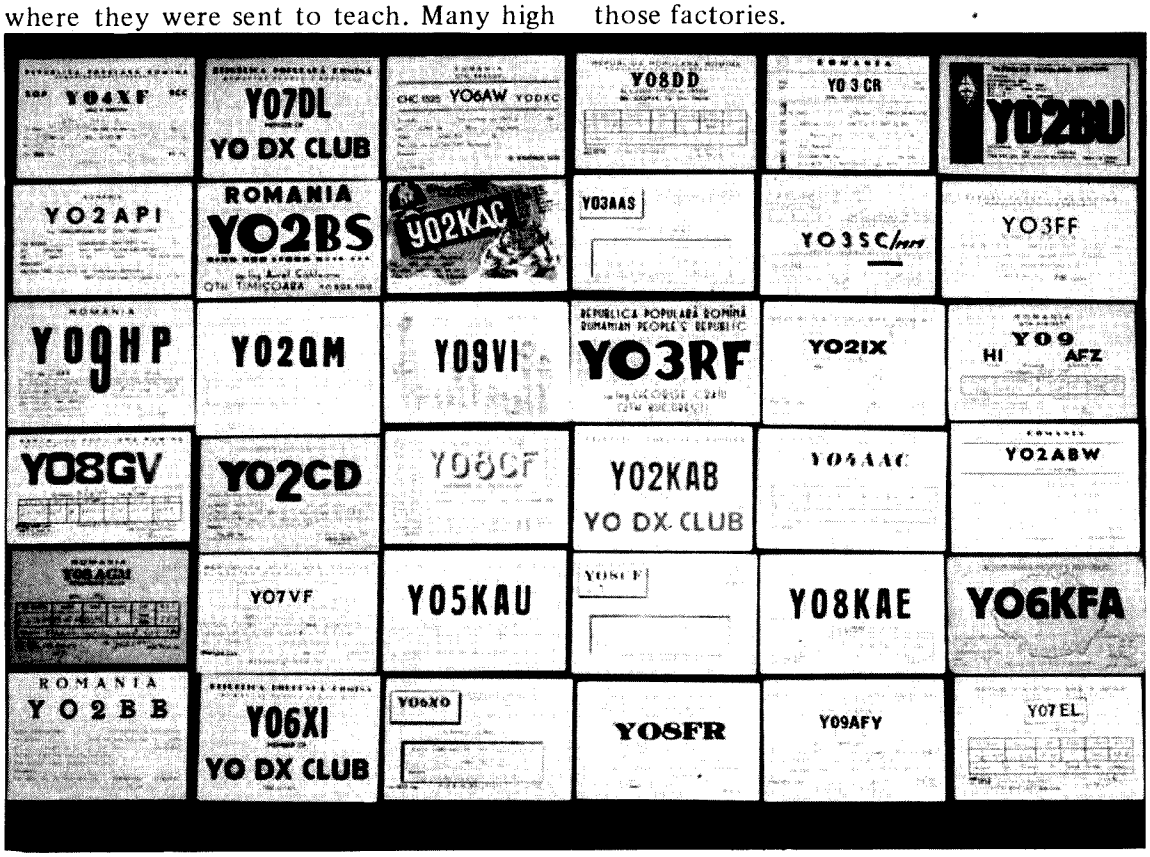
inhabitants; YO6KAF in Brasov, an 800-year-old town in the heart of the Carpathians, YO6KAL in beautiful Sibiu, an ancient town of medieval appearance; YO7KAJ in Craiova, a large industrial city situated on the Danube plain; YO8KAE in Iassy, the cultural and university center of Moldavia; YO8KGA in Suceava, center of the Bukovina region, noted for its 15th and 16th century monasteries, covered with lovely and authentic frescoes; and YO9KAG in Ploiesti, well-known for its rich oil fields.

In the capital city of Bucharest, YO3KAA is the club station of the Central Radio Club, the headquarters of the Romanian amateurs, and YO3KBN is its second station.

Besides district clubs there are many other clubs. For example, many universities have their own radio clubs. These are generally well-equipped, with a group of enthusiastic students operating the station. YO5KDK is the club station of the Pedagogic Institute of Cluj. After graduation, many of its operators, in love with amateur radio, organize new clubs in the schools where they were sent to teach. Many high schools also have radio clubs. YO4KCE in Galatzi was built and is operated by the organizing teacher and his best students. The teachers and the parents like to see the kids spending their spare time in a useful way. The students learn basic electronics and code. By operating the club station they are also increasing their knowledge in world geography, in foreign languages, etc.

In every city or village in Romania there is a "pioneers' palace" where the children can learn things normally outside the school cirriculum. YO2KAC, the club station of the pioneers' palace from Timisoara and YO9KDP of Cimpina are operated mainly by young high school students. Under the supervision of their teachers, they also do all the construction work and the maintenance of their station.

Many factories also have amateur radio clubs. For instance, YO3KBC is the station of a large electronics plant in Bucharest; YO5KDL is the radio club of a shoe factory in Oradea, and YO6KEM is the club station of a textile factory near Sibiu. These club stations were built entirely by technicians and engineers employed by those factories.



Some of the Romanian QSL cards received by W, K amateurs.



Aurel (YO2BS) Leo (YO2BM), and George (YO2BB) during their SSB expedition on the peak of the Semenic mountain. The receiver is a Lafayette HA-350 and the transmitter is homemade, built by George.

The Individual Stations

Many club members and operators of club stations also have individual stations at their homes. Some of them began in radio years ago as young pioneers. Mircea, YO2QM, and George, YO3FU, former operators of YO2KAC, are today top DX men. Aurel, YO2BS, who started his hobby as an operator of the district radio club YO2KAB, is now a broadcast chief engineer. George, YO3RF, is an internationally known oldtimer from Bucharest and cofounder of the YO DX Club. He has 260 countries confirmed and received 150 awards and certificates. George is very active on his own station and equally active in club affairs, teaching and helping the new generations of hams.

Cornel, YO3SC/MM, is on the trawler "Constantza." he is working a lot of DX and is visiting personally quite a few of the fellows he contacts. Another very active "Maritime mobile" is Stefan, YO4WV/MM.

Dietmar, YO7VS (ex-OE5ZIM, -OK8AAJ) is a radio technician for the Romanian Airlines in Craiova. He is an excellent DX man but he is more famous for his activity on VHF. On 144 MHz, Dietmar worked with 18 European countries, and his record is 1330 miles.

Using the meteor scatter technique he made 14 QSOs, the farthest with UA1DZ with only 30W input, at a distance of 1134 miles. Presently he is looking for a W–YO moonbounce QSO. Amateurs interested in this kind of experiment should contact him directly: P.O. Box 63, Craiova, Romania.

In Romania, there is a tendency to involve every active ham in club activity. Some teach code, others theory. Some are in charge of the shop or the library or the QSL bureau. Others are with the club station. There are committees for VHF, for field days, for organizing public exhibitions with gear built by amateurs. Other hams are managers for different YO awards and certificates.

A good example of teamwork was

shown in July 1968 by YO2BB, YO2BM, and YO2BS. They installed a rig in a chalet on the peak of the Semenic Mountain, on the southeast corner of the Carpathians. The altitude was 4760 ft; the weather was cold and rainy. But for 10 continuous days, their station worked hundreds of DX stations on 15, 20, and 80 meters. They used a homemade 100W SSB transmitter built by YO2BB, a Lafayette HA-350 receiver, a single-element quad for 15m and longwires for 80 and 20m.

Amateur radio activity in Romania is regarded as a sport and the amateurs are considered sportsmen. They often participate in competitions. The scores obtained on various national and international shortwave contests, code proficiency competitions, the results of the "foxhunts," like the quality in designing and building ham gear, determine the rank of an amateur radio sportsman.

For very high achievements, the National Counsel for Physical Education and Sport could confer special distinctions and honorary titles. A short time ago the following top YO hams received the "Master of Sport" title: Victor, YO6AW, from Brasov; Victor, YO7DO, from Craiova; and George, YO3RF; Petre, YO3FF; Vasile, YO3CR, from Bucharest. Vasile has been a ham since 1948, and has made over 10,000 QSOs. He also has nearly 200 countries confirmed, has more than 180 awards and certificates and is very active in club committees.

The competition among the hams is strong, but friendly. Many times an experienced ham will have around him at the club or in his home a group of youngsters, who help him and learn from him at the same time. The average age of the YO ham is below 30 and the number of licensed amateurs is growing rapidly.

In many tiny villages, as soon as electric power is introduced a beginner will build an amateur radio station. He is usually a teacher, or the agronomist, or the doctor of the village. Soon, others join him and spend their evenings together, watching him making QSO after QSO, then helping him build a new transmitter or install an antenna. And suddenly a new club is born.

YO awards

The Romanian Federation of Radio Amateurs issues 20 different awards, under the following general rules;

- Bands: 3.5; 7; 14; 21; 18 and 145 MHz.
- Mode: CW, AM, SSB, Mixed.
- Mode: CW, AM, SSB, mixed.
- All contacts have to be confirmed by QSL cards, YO cards being in the applicant's possession. Exceptions to this rule may be granted for QSOs made during the international contests.
- YO awards are not issued for various modes, but each class is a separate award.

The application and the log will be sent to: Central Radio Club, Box 1395, Bucharest 5, Romania. The log will be certified either by the awards manager of the association, or by two licensed amateurs, having checked the validity of the QSL cards.

The fee for any award and class is 7 IRCs or $1 (packing and mailing included).

All SWLs may get these awards in accordance with the rules.

The awards will be issued only after the YO stations listed in the application log have received the applicants QSL card. When there are fears that cards have been lost, the applicant is urged to send new QSL cards for the YO hams, together with his application.

Here are some of the YO awards:

YO-WAD (Worked All YO Districts). The award is issued for two-way contacts with YO stations located in all YO districts, namely: YO2, YO3, YO4, YO5, YO6, YO7, YO8, YO9.

The award has 3 classes:

- Class 1: for working all 8 districts,
- Class 2: for working 6 districts,
- Class 3: for working 4 districts.

Each YO district worked will be awarded by a specific seal on the certificate.

A district is considered to be fully worked, after two-way contacts with a minimum number of YO stations located in that district, depending on the applicant's location zone, as follows:

YO–AM (YO Alma Mater). This festive award is issued to celebrate the 100th anniversary of Bucharest University.

Location zone	Number of QSOs needed for each district		
	Class 1	Class 2	Class 3
15, 16, 20	10	6	3
14, 17, 21, 33, 34	6	4	2
All other zones	3	2	1
YO hams	15	10	5

A YO station may be worked but once.

YO–AM (YO Alma Mater). This festive award is issued to celebrate the 100th anniversary of Bucharest University.

Depending on his location, the applicant has to gather the following number of points:

Location zone	Needed points	Points scored per contact				
		3.5	7	14	21	28 MHz
15, 16, 20	60	3	1	1	4	8
14, 17, 21, 33, 34	40	4	2	1	3	6
All other zones	20	8	3	1	2	4

Working the same YO station on several bands, the points scored for these contacts will be multiplied by 2 for 2 bands, by 3 for 3 bands, by 4 for 4 bands, and by 5 for 5 bands. For instance: A ham located in zone 33 had 4 contacts with the same station on 3.5; 7; 14; 21 MHz bands. The overall score for these contacts will be: 4+2+1+3=10x4=40 points, which is enough to get the award.

YO–UBZ (Worked Balkans Peace Zone). This award is issued in 3 classes, in accordance with the following rules:

(a) European stations must carry out two-way contacts with a minimum number of countries and districts as follows:

– Class 1: 6 countries and 18 districts
– Class 2: 5 countries and 15 districts
– Class 3: 4 countries and 12 districts including a minimum of 6 YO districts.

(b) Stations outside Europe:

– Class 1: 5 countries and 10 districts
– Class 2: 4 countries and 15 districts
– Class 3: 4 countries and 12 districts including a minimum of 3 YO districts.

Balkan countries and districts considered for this award are:

1. Bulgaria LZ1, LZ2
2. Greece SV
3. Crete SV
4. Dodecanese SV
5. Turkey TA (European part)
6. Albania ZA
7. Romania YO2, YO3, YO4, YO5, YO6, YO7, YO8, YO9.
8. Yugoslavia YU1, YU2, YU3, YU4, YU5, YU6.

The award is also issued for two-way contacts with one YO station, and two different stations in two different countries, on 2m band.

YO–10 x 10 (Worked 10 YO on 10 Meters). There are needed 10 two-way contacts with 10 YO stations on 10m band.

A YO station may be worked but once, regardless the mode of the contact. There are similar awards for all bands (15 on 15m, 20 on 20m, etc.)

YO–DX–C (Worked YO DX Club Members). There are needed two-way contacts with YO DX club members, as follows:

Romanian hams	10 QSOs
Hams in European countries	5 QSOs
Hams in the rest of the world	2 QSOs

The members of the YO DX Club specify this quality of their QSL cards.

Foreign amateurs completing the required conditions for the award during a YO contest, may apply for honorary membership in the YO DX Club.

YO–45–P (Worked Parallel 45). There are needed contacts with radio amateur stations of the countries located on 45th parallel:

North America: W7, W0, W9, W8, VE3, W1, VE1, FP8
Europe: F, I, YU, YO, UB5, UA1, 3, 4, 6
Asia: UL7, UI8, JT1, BY–BV, UA0, JA.

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Campaigning for ARRL Directors

It's nearing campaign time for directorships in the ARRL, and a lot of good men – and bad – will be actively seeking office. You readers have practically convinced me that the best way to improve the League is from the inside, so maybe an effective group of directors would be the right start.

So . . . how about it? Do you know of any candidates who are especially suited to serve? Or who aren't? Write 73 and give us the lowdown on the prospective candidates in your division.

And how about the directors already in office? How are they performing? You *can* do something. Write your division director a letter and ask how he feels about issues you consider important. Does he think a lobbyist in Washington would help ham radio? How does he feel about incentive licensing? What are his views on repeater rulemaking? About the increase in license fees? Does he plan to put any pressure on the boys at headquarters?

Find out if he keeps informed on League affairs. Ask him if he knows what lawsuits (involving amateurs) the League is helping with. What kind of help is the League offering? How many dollars? How much of the League attorney's time?

You hold a lot of power in your hand as a League member. And you can use it very effectively by telling the whole amateur world which individual you think is best qualified to hold office in your division.

. . . K6MVH ■

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SAMPLE B-1: 8 I. C. Mounting blocks – over 50 resistors – 32 transistors – over 30 diodes – complete with board.

SAMPLE B-2: 32 transistors – over 100 resistors – capacitors – over 15 diodes – complete with board.

GROUP C – **Actual Value $50.00 – PEP Price $4.50**

SAMPLE C-1: 22 in-line I.C.s – over 75 diodes – 20 trans. – over 50 resistors – capacitors – complete with board.

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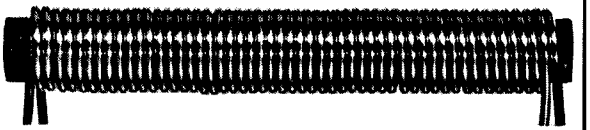
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– Class 3: 6 contacts with 6 countries.

One contact with each country. A YO contact is obligatory in all cases.

Valid contacts: after January 1, 1960

YO–25–M (Worked Meridian 25)

There are needed contacts with amateur stations of the countries on the 25th meridian:

Europe: LA, OH, UP2, UQ2, UR2, UC2, UB5, YO, LZ, SV

Africa: 5A, SU, TT8, ST, TL8, 9Q5, 9J2 (VQ2), ZE, ZS1, 2, 4, 5, 6.

– Class 1: 18 contacts with 18 countries

– Class 2: 12 contacts with 12 countries

– Class 3: 6 contacts with 6 countries.

One contact with each country. A YO contact is obligatory in all cases.

YO–20–Z (Worked Zone 20). This award is issued in three classes, for contacts made with amateur stations of the countries belonging to zone 20:

Bulgaria (LZ), Crete (SV), Cyprus (5B4,ZC4), Dodecanese (SV), Greece (SV), Israel (4X4), Jordan (JY), Lebanon (OD5), Romania (YO), Syria (YK), Turkey (TA) as follows:

Location zone	Minimum No. of countries worked		
	Class 1	Class 2	Class 3
15, 16, 20, 21 34	10	8	6
14, 17, 22, 23, 33, 35, 36, 37	8	6	4
All other zones	6	4	2

A YO contact is obligatory in all cases.

YO–5 ON 5 (Worked 5 Continents on 5 Bands). There are needed 5 two-way contacts with 5 DX continents, each on a different band; 3.5; 14; 21; 28 MHz.



The pan pipes are played in Romania's southern provinces (YO3, YO4, YO7, and YO9).

There are 6 continents: Asia, Africa, Europe, North America, South America and Oceania. Own continent does not count for this award.

Additionally are needed a number of YO contacts as follows:

European stations: 3 YO contacts

DX stations: 2 YO contacts

YO–LC (Worked YO Large Cities). There are needed anumber od contacts with YO stations residing in the large cities of Romania:

Bucharest	Lugoj
Alexandria	Medgidia
Arad	Medias
Bacau	Oras Gheorghiu-Dej
Baia Mare	Oradea
Birlad	Petrosani
Botosani	Piatra Neamt
Brasov	Pitesti
Braila	Ploiesti
Buzau	Resita
Calarasi	Roman
Cimpina	Rosiorii de Vede
Cimpulung Muscel	Rimnicu-Vilcea
Cluj	Sibiu
Constanta	Sighetul Marmatiei
Craiova	Sighisoara
Deva	Suceava
Fagaras	Timisoara
Focsani	Tirgul Mures
Galati	Turda
Giurgiu	Tulcea
Hunedoara	Turnu-Severin
Iasi	

Only one contact is allowed with each of the cities mentioned above, regardless of band, or mode.

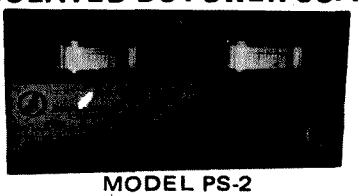
– Class 1: 30 cities
– Class 2: 20 cities
– Class 3: 10 cities

YO–NC (Worked Namesake Calls). This award is issued for at least 5 two-way contacts between partners having the same personal 1, 2, or 3 call letters after the district (or state) figure.

For instance: I1ACD, JA1ACD, LU1ACD, WA1ACD, PY2ACD, etc. The same station may be worked but once.

Radio amateurs having a callsign with two call letters after the figure, must make

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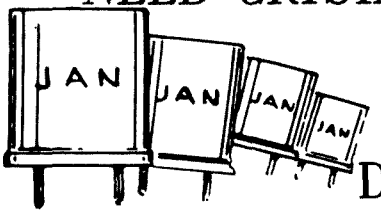
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also a "namesake" contact with a YO station.

Some of these awards are easy to obtain, others are more difficult. It is a worthwhile effort trying to get any of them. Larry, K2UMM, found that he satisfied the requirements for 9 different YO awards. He made up the logs and sent for them right away.

Romanian hams QSL almost 100% and it takes approximately 3—4 months to get these beautiful awards.

In YO land, the hams cannot subscribe to the western radio publications and they are always appreciative when they receive some old copies of 73, QST, CQ or Callbooks.

Romania is a very interesting country. Its natural beauties and the friendliness of its inhabitants attracts more and more tourists. The YO amateurs stretch the rules of hospitality when a foreign amateur visits their country. In a short period of time the following visiting amateurs got the red-carpet treatment: Franco, I1FO, from Milan, Italy; Zbyszko, SP5ZK, from Warsaw, Poland; Janos, Ha5AM, from Budapest, Hungary; Ludwig, DM2CHM, from Leipzig, Germany; Jim, W8FXP, from Jamestown, Ohio; George, K8NEY, from Albion, Michigan; and Lee, W6MNN, from Gridley, California.

Working an amateur in another country is a little like being there. By talking to a ham you can learn about his life, his country, his goals. Why don't you try to learn a little about a far away but interesting land, YO country?

. . .YO2KAC



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.... Bill Turner WAØABI

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should be boiled in oil ov

Repeaters

Your articles and backing for repeaters (FM) and associated operation are great, although your open-repeater-directory was not fully accurate. It was, however, stupendous, and of very effective help during my recent trip across the country and back. Maybe in a year or so, when the FCC gets a decent repeater rules concluded, you can call for info and publish a good, up-to-date list, under separate cover and for $1, with a new directory published yearly. Lots of luck.

Ray Bilger W3TDF

Directories are hard to keep up-to-date, but we're trying. The update currently being prepared has more than 100 new repeater entries plus about 100 changes in existing relays.

. . . Ken

Propagation

Please convey my thanks to your propagation analyst, Mr. John Nelson. His successive forecasts of three poor Sunday's in a row have been 100% accurate from this QTH. So thanks for this service. . .very much appreciated.

Neil Johnson W2OLU
74 Pine Tree
Tappan NY

Our analyst has received national acclaim and many honors for his predictions, many of which baffled even government experts.

. . . Ken

Favoritism

Rev. Peter Gonos (K6GZN) takes the FCC to task for not giving a blind person special consideration ("Letters," June 1970). I agree that the examiner was a grouch, but publishing vague accusations is not the way to handle this situation. Public servants with a public-be-damned attitude can be removed from contact with the public if one complains in the right places. I assume K6GZN could name names, place, time, and other pertinent facts.

Robert Newman WA7IEH
Box 283
Estacada OR

Censorship

When I picked up a copy of the FM Repeater issue of 73 at a local ham store, I was very favorably impressed.

I then noticed a column which mentioned the writer's objection to Latin America-to-Miami phone patches (he'd rather that *he* use the frequencies). Well, he's entitled to his opinion, though I'd say DX phone patching is "more important" than DX ragchewing.

He then goes on to suggest (very obliquely, of course) that we ship the Latin Americans in the

Miami area back where they came from. He thus shows his ignorance of what belongs in an amatuer radio magazine, and, perhaps, of what it means to be an American, and what makes this country great.

Anyone who could write something like that is beyond reaching, but where was the editor? I hope to see a retraction in a future issue of 73, so that I may, in good conscience, subscribe to what appears to be an excellent radio magazine, when it sticks to that area.

Michael Gershman WA3OOB
11550 Stewart Lane
Silver Spring MD

You are calling for censorship. . .are you really in favor of that? Do you really feel that I should not print things in 73 that I do not agree with? 73 prides itself for its policy of publishing all intelligent sides to various issues.

. . . Wayne

Feedback

The following is an adaptation of an experiment common in most basic college physics courses.

There is an easy way to automate the comparison of light intensities used in KICLL's wattmeter. (August 73) Mount the two bulbs rigidly and place a small square of shopping bag paper, which has a spot marked in the center, with margarine or some other light oil, exactly equidistant between the two bulbs. When the bulbs have the same intensity, the spot on the paper will seem to disappear. The paper must not be exposed to strong external sources during measurements. This method should also greatly increase accuracy.

Alan P. Biddle WA4SCA/7
Box 10866
Tuscon AZ

The League and 73

I notice you punching up the ARRL which I think needs to get up with times. I don't subscribe to QST; for one reason, it costs too much for the couple of writeups I could get some use out of once in a while. The rest of the magazine is filled with contests and League doings, and when you save a pile of QST you got about 9 times as much paper as you need to fumble through to find something on that antenna or what have you. I do think ARRL is doing a good job on the code practice sessions and I do think that our extremists should quit QRMing that session each night for the short time they are on. After all, they have been doing it for years now so the oldtimers should know it's there.

Orville Gulseth W5PGG
1435 King St.
Clarksdale MS

Moonbounce

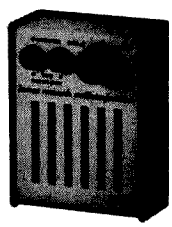
Anyone in Chicago/South Bend area working on moonbounce? Would like to contact others who share my interest.

Phill Chasey WA9GAA
506 W. Angela Bl
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my feet in preparing for the General class examination. Having had some electronic instruction at Fort Monmouth back in my Army days, I have concentrated mostly on the code, believing that the theory wouldn't take much effort. I have been brushing up on theory for quite some time by studying an NRI course, supplemented with a couple of AMECO books and several of those published by the ARRL. It would seem that this would be sufficient preparation for the FCC exam. However, I will have to admit that I have never *really* understood some of the very basic principles of electricity and electronics and I have been relying on my ability to memorize what I have repeatedly studied, hoping that someday the understanding would finally dawn.

Last weekend I stopped by the local electronics store to pick up a copy of QST and I happened to notice on the cover of 73 that here was a new study series on getting the General ticket, so I bought both the July and August issues. I can't explain what a stroke of good fortune this has turned out to be for me. I had just about decided that thorough understanding of electronic and electrical theory required some natural ability that I happened to be born without.

Thanks to 73 I now have a much better understanding of the relationship of circuit components, voltage and current in electrical circuits, and that of resistance versus reactance. Looking back on the past, I can see that my particular problem has been that when I would read something I didn't quite clearly understand, I would skip through that section of the material with a vague idea of what the writer was trying to convey and go on to something easier to comprehend. This, obviously, has hindered my ability to approach new knowledge with comparative ease.

More specifically, I have been able to understand how each electrical component works by itself and have learned the characteristics of various circuits, but I have always had trouble understanding the interaction of the components of circuits and the formulas used to arrive at answers to required values. I am anxious to study the next installment and I feel that when I take the exam for the General ticket I will be grateful to 73 for giving me a sorely needed lift.

Having gained from studying this material, I began reading some of the other articles in the two issues and have discovered that 73 is the most refreshing ham publication I have read. To a beginner it is a big help to know that someone is interested in his efforts to become an amateur and willing to be of help, rather than taking the attitude that amateur radio is for a selected group in which membership is by invitation only.

John Leach
Metairie LA

Hobby License

Apparently your left hand does not know what your right hand does! I refer to your coupon asking that the FCC give up the 220 MHz band to a hobby type service requiring no examination.

In your editorial you make the statement, "Since the ARRL has set aside $100,000 for the defense of our amateur frequencies it seems

logical to me that it is up to them to make a definite move in this direction." Can you explain to me whi in one statement you indicate the ARRL is not defending our frequencies to the utmost, yet in another portion you are attempting to give away one segment of our frequencies to a group of people in the same category as the CB'ers?

You indicate in your Action Coupon, "Amateur radio has been stalled for seven years now. . ." Apparently you have not participated in the hobby of amateur radio for seven years because I can hardly see indications of amateur radio being stalled. It would seem to me that amateur radio has made more progress in the last ten years than they had in the preceding ten years.

I cannot see how giving 220 MHz to a group of people without examination could correct the present chaotic conditions in CB. If you will think back a few years you will remember citizens radio originally was in the 450 MHz band and was used very little by CB'ers.

Robert Johnson WA0 PVW
5544 Blue Ridge Blvd
Raytown MO

The proposal is not to GIVE part of 220 away. It is to USE part of 220 to attract more hams. For the past seven years the number of new amateurs has been declining.

. . . Ken

FM Calling Channel?

The frequency must of course be one not presently used, or used by the least number of persons. I would suggest that 146.910 be considered.

Robert S. Katson W1HBH
59 Meadow Brook Dr.
Monroe CT

Do we really need it? 146.94 is admittedly a national repeater output frequency, but it IS monitored by just about everyone on FM. FM'ers in repeater areas can operate through their local systems and get a contact almost anytime, particularly where there is an emergency. Where there is no repeater, there is still .94. When it is so easy to contact another station on .94, why try to set up another channel — one that probably wouldn't be monitored anyway? Repeater transmissions are usually kept short enough to



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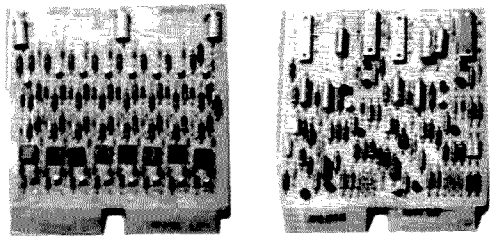


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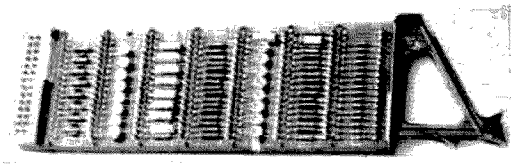
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allow any user to get in within a minute or less. And if users get out of the habit of "tail-ending" other users, a brief monitoring period would be available at the end of each station's transmission. Who could ask for a more efficient emergency communications setup?

. . . Ken

Article Policies

Some other ham magazines may take years to pay for an article, but you guys are something! You paid me $20 for a short article which you never printed (sent to you 1 year ago).

Gabe Gargiulo WA1GFJ
160 Elm
North Haven CT

We liked your article and bought it. Now it's working its way toward the top of the heap.

. . . Ken

From the Lunatic Fringe. . .

I have been reading your magazine for many years and have enjoyed it but I never felt that your comments on the ARRL, and your advice and insinuations were in good tast or even good sense.

I do feel that you are doing ham radio and hams a great injustice, since your attacks on the ARRL do incite the lunatic fringe that has infiltrated ham radio, and these degenerate vicious slobs play such tricks as jamming of the CW practice sessions, hurting new hams or potential hams who are trying to get that code practice, which is being denied them. In short, this is at least one of several forms of damage and injury, your tirades may be responsible for. Only the lunatic fringe and the weak minded would respond to those articles and only in the modes I have mentioned.

Also I noticed that when that gang of long-haired cowards utilized the college radio clubs to propagate their destructive and idiotic policies on the air and on ham bands, those who wrote to your magazine and objected to same were answered with jeering and smart alecky retorts. If you don't think that such use of the ham bands *could* very easily result in total loss of ham privileges, you are not fit to be running a ham magazine.

I have decided not to renew my subscription, and if enough of us oldtimers feel the same about it, you may find yourself going into bankruptcy, unless of course, you are being financed by Russia, Cuba, or dope sales.

Jacob Dubrusky W2LVR
Box 482, Flushing
Queens, NYC NY

Good Grief! *. . . Ken*

Code

I have been reading with great interest the comments by some hams about the new licensing requirements. . .particularly about code requirements. I would very much like to become a ham operator. Only one thing keeps me from fulfilling that desire: CODE.

I have spent endless hours trying to acquire a code speed sufficient to get a license, but have

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☐ 908	Full adder	5
☐ 909	Buffer	5
☐ 910	Dual two input gate	5
☐ 912	Half adder	5
☐ 913	Shift register	5
☐ 914/921	Dual 2 input gate	5
☐ 923/940	J-K flip flop	5
☐ 925	Dual 2 in. w/expand	F

Type	Description	Case
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☐ 960	Dual buffer	5
☐ WC210**	2-3 in line driver	F
☐ WC215**	J-K flip flop	F
☐ WC226**	Triple 3 In. gate	F
☐ WC227**	10 In. Diode expand	F
☐ WC261**	Dual 4 In. gate	F
☐ WC266**	Quad 2 input gate	F
☐ SG-43 ***	Dual 3 In. gate	N
☐ SG-123***	Expandable 8 In. gate	N
☐ SG-163***	Triple 2 In. bus driver	N
☐ NE-124**	R-S-T binary	F

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never been able to pass the test. At one time I received three hours of code training daily, five days a week for six months; but at the end I could not pass a 16 wpm test.

However, I would make a good ham operator, as far as technical ability is concerned. I have held a First Class radiotelephone license for over 25 years. During that time I have been actively occupied in radio and electronics, in many different areas. The technical test would be no problem and I might even contribute some worthwhile ideas to ham radio.

I don't believe that code will ever completely die out, but it has been replaced in many ways with other types of transmissions. Now you can even buy an automatic code sender that will convert typed characters to code equivalents. Very little would be lost to the ham world if noncode operators were licensed. Those who wished to operate with code could pass a supplemental code test.

But please let's not keep up the howl... "anyone can pass the code if they really try," because I have really tried – and can't!

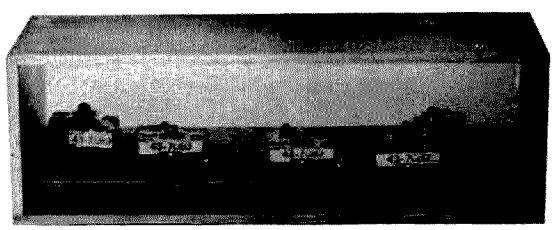
Ernest T. Robarge

Satisfied Lifer

The time has come for another auto de fe. Please enroll my second son for life, for which I enclose $50. You might be interested to know that this is the third lifetime subscription to your magazine I've given away. The idea is to lure the recipients into the more technical end of the sport.

F.M. Burton

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ARC-27 2M Guard Channel Receiver.
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R508/ARC, June 1965 page 48, before & after.
73 Magazine, Peterborough, N.H. 03458

73 Reader Service Coupon

Now we don't say that every single reader must buy every last product advertised in 73. We believe that, but we don't say it. The very least every reader can do is to put on a show of interest in the products herein advertised. To make this a simple task, even for the laziest reader (now there is a contest for you!), we have cleverly arranged the advertising index to double as a readers service coupon. All you have to do is tear it out (or photocopy it) and send it in with the appropriate boxes marked. (We have a prize for the most boxes marked . . . a silent prayer of thanks from the publisher). We'll accept postcards, slips of paper, or almost anything else that lists the companies you want to hear from and your address.

No one likes to go into a store without buying something, right? It is the same with these information requests. You will be expected to buy something. Oh, it doesn't have to be a $50,000 antenna system, but it should be something modest . . . a transceiver . . . a linear . . . you know. We'll leave the decision up to you, knowing that we can trust you to do the right thing.

And we are definitely not saying that the use of this service coupon has any curative powers, but we cannot but notice that many readers report remarkable relief from simple backache, headaches, lumbago, and acid indigestion after sending in their coupon. Why take any chances?

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- ☐ Amidon 81, 101
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October 1970

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EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	7A	7	7	7	7	7	14	14A	21	21
ARGENTINA	21	14	14	14	7	7	14A	21A	21A	21	21	21
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14B	14	14	21	21
CANAL ZONE	21	14	7A	7A	7	7	14	21A	21A	21A	21A	21A
ENGLAND	7	7	7	7	7	7A	14A	21A	21A	21	14	14
HAWAII	21	14	14B	7B	7	7	7	7B	14	21	21A	21A
INDIA	7B	7B	7B	7B	7B	7B	14	21	14	14	14	7B
JAPAN	14	14	7B	7B	7B	7	7	7	7B	7B	7B	14A
MEXICO	21	14	7	7	7	7	14	21	21	21	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7B	7B	14B	14	14	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21A	21A	21A	21	21
SOUTH AFRICA	14	7	7	7B	7B	14	21A	21A	21A	21A	21	21
U. S. S. R.	7	7	7	7	7B	7B	14	21A	21	14	14	7B
WEST COAST	21	14	7A	7	7	7	7	14	21	21	21A	21A

CENTRAL UNITED STATES TO:

ALASKA	21	14	14	7	7	7	7	7	14	21	21	21
ARGENTINA	21	14	14	14	7	7	14	21A	21A	21	21	21
AUSTRALIA	21A	21	14	7B	7B	7B	7B	14	14	14	21	21
CANAL ZONE	21	14	14	7A	7	7	14	21	21A	21A	21A	21A
ENGLAND	7	7	7	7	7	7B	7A	14A	21	21	14	14
HAWAII	21A	21	14	14B	7	7	7	7	14	21A	28	21A
INDIA	14	14	7B	7B	7B	7B	7B	14	14	14	14	7B
JAPAN	21	14	7B	7B	7B	7	7	7	7	7B	14	21
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21A
PHILIPPINES	21	14	14B	7B	7B	7B	7B	7B	14	14	14B	21
PUERTO RICO	21	14	7	7	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA	14	7	7	7B	7B	7B	14	21A	21A	21A	21	21
U. S. S. R.	7B	7	7	7	7B	7B	7B	14	14	14	14	7B

WESTERN UNITED STATES TO:

ALASKA	21	14	14	7	7	7	7	7	7A	14	21	21
ARGENTINA	21	21	14	14	14	14	7B	14A	21A	21	21	21
AUSTRALIA	28	28	21	14	14	7B	7B	7B	14	14	21	21
CANAL ZONE	21A	14	14	7A	7	7	7A	14A	21A	21A	21A	21A
ENGLAND	7B	7B	7	7	7	7B	7B	14	14	21	14	14B
HAWAII	28	21A	21	14	7A	7	7	7	14	21A	28	28
INDIA	14	14	14	7B	7B	7B	7B	7B	14	14	14	7B
JAPAN	21A	21	14	7B	7B	7	7	7	7	7B	14	21
MEXICO	21A	14	7	7	7	7	7	14	21	21	21	21A
PHILIPPINES	21A	21A	21	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	14	7	7	7	7	14A	21	21	21A	21A
SOUTH AFRICA	14	14B	7	7B	7B	7B	7B	14	21	21A	21A	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	7B	14	14	14	7B
EAST COAST	21	14	7A	7	7	7	7	14	21	21	21A	21A

A = Next higher frequency may be useful also.
B = Difficult circuit this period.

amateur 73 radio

#122
One Dollar
November
1970

IN THIS ISSUE:

NOVICE XCVR PROJECT

LOW-COST KEYER

BUILD A WATTMETER

ENERAL STUDY GUIDE

Amateur Radio News Page

November MCMLXX — Monthly Ham News of the World — 73 Magazine

ELEVENTH ANNUAL NOVEMBER ISSUE

Through thick and thicker 73 has, to the disappointment of its detractors, somehow managed to survive. This survival has frequently been quite marginal, as the gaunt but dedicated little group which publishes the magazine will testify.

One of the things that has kept morale high at 73 is the ability to publish humorous little items which are obvious only to the more intelligent readers, items such as the announcements of new certificates for amateurs contacting the editors of the other ham magazines, knowing full well that these chaps are inactive and have been either for years or life, and have their call letters as a subterfuge because they are editors.

It is an interesting statistic that 73 has, in its ten years of life, published almost as many technical and construction articles as QST has in fifty years! In its short lifetime 73 pioneered first the Nuvistor, then the transistor, and now the IC. The large number of articles published has allowed 73 to cover all aspects of the amateur radio hobby while still pushing the new developments such as ATV, RTTY, and FM.

The editorials in 73, though often accused of being anti-ARRL by League stalwarts who either have not read them or else have read them carelessly, are proamateur radio and anti any person or group who is doing battle by our Nell. Where the ARRL has done particularly despicable things such as at the New York World's Fair, in the Don Miller affair, and things like that, 73 is critical. Would you have it any other way?

No 73 Display At Hudson Convention

Despite assurances from several ARRL officials that a 73 display and booth at the New York Hudson Division ARRL Convention was out of the question, both the publisher and editor tried valiantly to convince ARRL Director Daniels to let the magazine in. He flatly and steadfastly refused to permit 73 to exhibit either in its own booth or in conjunction with any other exhibit.

Hudson Division ARRL members should be proud of Director Daniels' strength of conviction, no matter what fairness and decency would seem to demand of him.

ZA2RPS COMES THROUGH

The OH2BH expedition to Albania in August was over almost before it started, with under 800 contacts made before being shut down by authorities. Thus not too many amateurs were convinced that Frank Turek DL7FT would be able to pull off his promised try at getting on from ZA.

As reported in the West Coast DX Bulletin, Frank was supposed to start operation about September 15, but was only heard for a short time. The rumor mills started grinding at full tilt. 1. He would be on CW only. 2. He would favor California stations. 3. He was back in Germany and being worked from home. 4. His papers were not in order and he was not allowed into Albania. 5. He was on the air but from outside Albania. 6. The transmitter was giving trouble. It was a tense time for the DX'ers indeed.

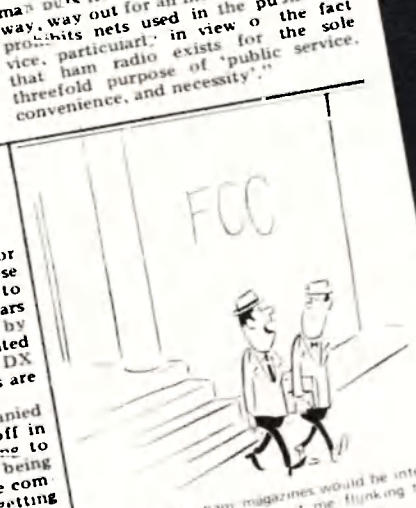
On September 15th Frank and DJ0UJ opened up full bore and spent full time working everyone available until 0800 Friday (18th). Few serious DX'ers missed working Albania this time.

EYEBANK DEFIES FCC

In spite of the notice of illegal operation issued to operators of the renowned eyebank net by the Federal Communications Commission, the net is continuing to function routinely. The FCC says the eyebank net is illegal because it was formed originally by the Lions Club, a nonamateur organization. But hams don't agree with the ruling. "Public opinion, ... one amateur, is on our side. ... When the FCC gets enough power to jeopardize the lives of American citizenry, things are bad. But when the Commission actually uses that power, things are intolerable." The only way to bring the matter to a head, he indicated, was to ignore the FCC ruling and wait for the fireworks.

In Washington, FCC staff members are themselves more than a bit embarrassed by the situation. James Barr, chief of the FCC's Safety and Special Services, blames the hams for the predicament. It was a ham who brought the whole thing about, he said, because he wanted a literal interpretation of a somewhat ambiguous ruling. "Somebody asked a question and we had to give a straightforward answer. ... It would be better if they didn't ask the question."

Some hams, though, throw the blame back on Barr. His interpretation of the ruling, they say, borders on the sublime. As one noted amateur spokesman puts it: "The Fed has got to reach way, way out for an interpretation that prohibits nets used in the public service, particularly in view of the fact that ham radio exists for the sole threefold purpose of 'public service, convenience, and necessity'."



"Which of the ham magazines would be interested in a news item about me flunking the General 73 times?"

YI MAY BE ACTIVATED

Iraq is now the most unworked country in the world and, considering the Mideast situation, activity there at this time seems unlikely. Martin OH2BH promises to make a major try from the Finnish embassy ... This boast might be dismissed if it were not for his history of coming through on these promises. Martin was the first one to make it from Albania in many years and his operation there, followed by DL7FT, took 3A off the most wanted list for just about all of the top DX hunters. The October 17th pileups are frightening to contemplate.

Martin expects to be accompanied by OH2SE and they will stop off in Lebanon for a week before going to YI. One more document is being awaited before everything will be complete. The DX fraternity is getting edgy, beam headings for Iraq are being posted on operating desks, and airmail envelopes for the QSLs are already being addressed in expectation.

#122 November, 1970

amateur 73 radio

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Amateur Radio News Page

November MCMLXX | Monthly Ham News of the World | 73 Magazine

NEW PROPOSALS FOR ITU AIRED BY FCC

The latest Commission proposals for presentation to the 1971 World Administrative Radio Conference (WARC) of the International Telecommunication Union (ITU) to be held in Geneva, Switzerland, in 1971 have been issued by the Commission in Docket 18294.

A proposal by educational groups to allocate the 108 MHz frequency band for FM direct satellite broadcast was rejected because the Commission said that the signal from the satellite would represent a potential interference source over roughly one-third of the world. The current U.S. proposal covers a multiplicity of channels in the 88–100 MHz band.

A proposal suggested by some educational groups to reserve the 470–890 MHz band for direct satellite-to-home broadcast, the Commission stated, is consistent with the Commission's footnote accommodation of television broadcasting from space in the frequency band 614–890 MHz.

The suggestion by these groups to reserve the 2500–2690 MHz band exclusively for educational TV, public TV services, and other educational and noncommercial communications was not adopted by the Commission. Comments were invited, however, with respect to definite proposals to use this band in a manner compatible with other existing or proposed uses.

designated non-Government communication-satellite service bands for use as up-links.

The Commission retained in its proposals for the broadcasting satellite service a definition of the term "direct reception" as encompassing both individual reception by members of the general public and by those engaged in community reception-group viewing or listening. The Commission explained that its proposal visualized an evolutionary process beginning as a communication-satellite service to conventional earth stations for program distribution, progressing to a process in which service could be rendered to smaller earth stations for local distribution systems, and finally becoming a direct satellite-to-the-home service.

The Commission modified its proposals to include the requests of amateur radio service organizations that power flux density limitations not be imposed against the service, but that the service be governed by the normal constraints inherent to secondary status and regional allocations under which they have conducted terrestrial operations over the years – with the added stipulation that space techniques be permitted in the shared bands only if a reliable means of telecommand is provided to control emissions so as to prevent interference to stations of a primary service in the band. The Commission also suggested that amateur groups be given authority to use exclusive worldwide bands in the high frequency spectrum for space applications.

To minimize the probability of radio interference to space and planetary studies by radio astronomers, the Commission proposed that the WARC adopt a resolution urging the ITU member governments not to transmit from spacecraft in certain frequency bands in the region above the earth's ionosphere or from locations that could cause interference on the far side of the moon. It also suggested that the band 21.850–21.870 MHz be allocated exclusively to the radio astronomy service.

Interested parties were invited to file comments on these proposals by September 23, 1970, and replies by October 5, 1970. The Commission said it anticipated that the formal United States proposals would be transmitted to the Secretary General of the ITU on or about January 1, 1971, and that it would not expect to give favorable consideration to requests for extension of time for filing comments.

FCC Waives Third-Party Rule For Australis-Oscar

The U.S. and Australia have agreed to a temporary exemption to the international limitations on third-party communications, the FCC says. Chief James E. Barr, FCC Safety and Special Services Bureau, confirmed the exemption in a letter to E.J. Wilkinson, the director general of Australia's version of the FCC.

Barr said the waiver would be valid "between certain Australian amateur stations and United States amateur stations to permit the exchange of information on matters relating to the next amateur satellite experiments." The arrangement is effective now and will remain in effect until "four months after the satellite ceases to transmit."

HAM LOSES FIGHT TO KEEP ANTENNAS UP

The current U.S. proposal for the use of the 2550–2690 MHz band contemplates space-to-earth transmissions in the earth sciences satellite service, with one or two sophisticated earth stations, remotely located, using extremely sensitive receiving systems capable of using power flux densities well below the sensitivity of Instructional Television Fixed Service receivers; and, in the 2500–2550 MHz band, communication satellite operations in Alaska, space-to-earth. In each case, the band would be shared with terrestrial services.

Broadcasting network interests, commenting on Commission proposals, expressed general agreement with tentative U.S. proposals, but stated that they are exploring alternative domestic satellite and terrestrial program distribution systems and may comment later on frequency needs.

The Commission had proposed earlier that there be sharing between the broadcasting-satellite and communication-satellite services in the 11.7–12.2 GHz band, with the communication-satellite service limited solely to the distribution of television program material. It decided that limiting the communications-satellite service solely to the distribution of TV program material would waste spectrum space, in view of the uncertain status of the broadcast-satellite service, and removed the limitation from its proposals.

On the question of choosing an up-link to send program material to the satellite for broadcasting in another band allocated to the broadcasting-satellite service, the Commission said that since broadcasting is normally a Commission-licensed function, it had

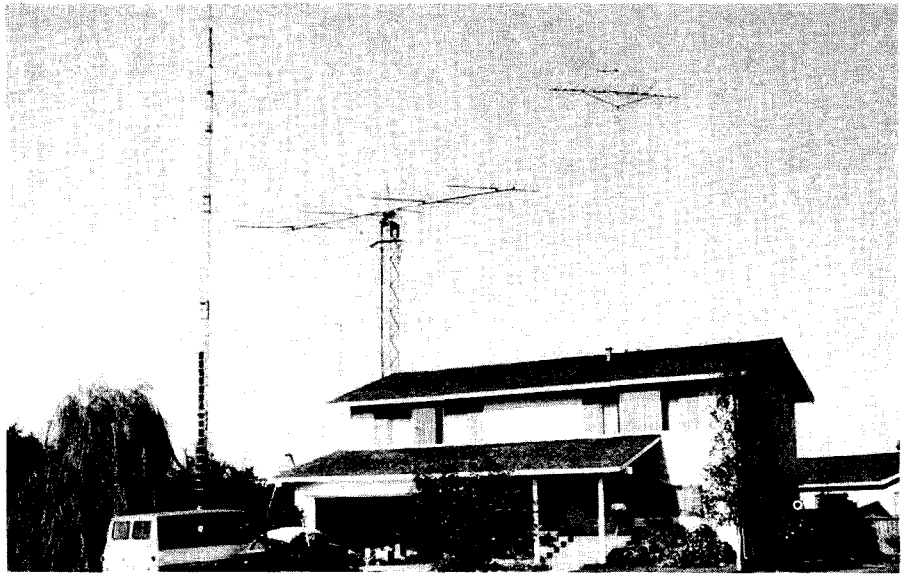
FCC Denies Proposal To Change EXTRA CLASS Requirement

A petition by Anthony R. Gorgano requesting amendment of Sections 97.21 and 97.23 of the rules to delete the 20 wpm code requirement from the amateur Extra license examination has been denied by the Fed.

In support of his request, Mr. Gorgano argued that only 13 words per minute is required for an amateur Extra license under Article 41 of the Radio Regulations, Geneva, 1959. He contended that improvement in the amateur radio service and advancement in skills in communication are a result of new techniques and experiments such as amateur satellites, slow-scan television, facsimile and repeaters, and single sideband, and that these advancements in voice communications skills owe nothing to the ability to expertly send and receive Morse code.

The Commission said that although it agreed that the 13 wpm code requirement is adequate to comply with international regulations and that code ability is unrelated to voice communications, it would, nevertheless, continue its practice of expecting candidates for the highest class of amateur licenses to possess more than a minimum acceptable level of competency in the communicating and technical phases of the art.

Which leads one to wonder why the FCC does not require today's amateurs to be skilled in such other unrelated communications media as smoke signaling, semaphore, drum-beating, and letter writing.



When Mike Staal (K6MYL), of San Jose, California, was ordered to lower his antennas because of a normally unenforced ordinance, he applied for a variance. At a public hearing, the local planning commission denied his request.

So Mike appealed the decision and attended another hearing. His neighbors stated that his antennas "detracted from the character of the neighborhood." Under closer scrutiny, however, the neighbors were thinking beyond "character." Some complained of his antennas "causing garbled reception on TV, stereo, and radio sets."

A local newspaper reported that Mike had suggested to one woman neighbor that the interference might be attributable to inherent problems within her own electronic equipment. According to the lady, she paid $50 subsequently for "unneeded" repairs The local newspaper quoted the woman as summing up her feelings with, "He's a pest."

Mike Staal isn't standing pat just yet. He has engaged a local attorney–ham and intends to press the issue. He also has notified ARRL headquarters and requested the League's assistance. In a four-page letter to John Huntoon (League's general manager), Mike Staal capped his request for aid:

Nine times out of ten if a ham's neighbors can watch TV, and or listen to their hi-fi stereo systems in peace – what the ham does antenna-wise or otherwise is strictly ignored. I hope the League and headquarters can begin some action to change the events that are bound to occur if the present situation continues.

73 News Society Page

1970 ARRL Roanoke Division Convention

The 1970 ARRL Roanoke Division Convention will be held in Raleigh, North Carolina, sponsored by the Raleigh Amateur Radio Society. Activities will begin on Saturday, October 31 and continue through Sunday, November 1. Governor Robert W. Scott will proclaim the following week (November 1 through November 7) as Amateur Radio Week in North Carolina in recognition of the public and community service performed by licensed amateur radio operators.

The convention, almost a year in planning, will include in its program a full variety of features to hold the interests of all devotees of amateur radio as well as their XYLs. Featured speakers will be highlighted throughout the convention, during both the individual programs and at the main banquet.

On Friday, October 30 from 1600–2200 EST, a talk-in to convention headquarters will be conducted on 75 meter SSB, 6 meter SSB, and 2 meter FM. The talk-in will continue from 0800–1200 EST on Saturday, October 31 for those arriving on that day.

Activities, commencing at 1000 EST on Saturday, October 31, will include items of interest such as a DX forum (hosted by the North Carolina DX Association), MARS programs, RACES and CD programs, manufacturers presentations, NET forum, FM and repeater discussions, state-of-the-art and space communications programs, and many more. Of particular interest will be the ARRL forum attended by Vic Clark, W4KFC, our \$2.75 per person with advance banquet tickets \$8.00 per person, a total of \$10.75. Registration at the time of the convention will be \$3.00 per person and banquet tickets will be \$8.50 per person, a total of \$11.50 at the door. Due to a limited number of persons able to attend the banquet, tickets will be sold on a first come–first served basis so get your requests in early. Hotel reservations will be available for those desiring them and will be made and confirmed by the pre-registration committee on request.

Watch your mailbox for further announcements concerning one of the finest ARRL Roanoke Division conventions ever held. Plan to come to Raleigh, North Carolina's capital city, for the 1970 ARRL Roanoke Division Convention on October 31–November 1.

Trillium Weekend

November 20–21, 1970

Trillium Weekend contest will be held by The Ontario Trilliums from 0300 GMT November 21 (7:30 p.m. EST Nov. 20) thru 0300 GMT November 22, 1970.

The Trilliums being the host club will call "CQ TW." All others will call "CQ TOT."

Exchange signal report, name, QTH, and Trilliums will give their club numbers. CW and fone contacts will each count as 5 points. Low-power

Annual Indiana QSO Party

This contest, sponsored by IUPUI Amateur Radio Club, will take place from 1900 GMT Saturday December 5 to 0600 GMT December 6, and from 1600 GMT to 2400 GMT on December 6. It is open to all amateurs. Same station may be worked on different mode and different bands. The exchange will be QSO number, report and state, province or country. Indiana may work other Indiana stations. Suggested frequencies: CW, 3535, 7035, 14035, 21035, 28035; PHONE, 3955, 7265, 14295, 21395, 28600, 50400 kHz. Scoring system: Score one point for each

TELEPHONE PIONEER QSO PARTY

by W2SNJ

The Stanley S. Holmes chapter of Ham Pioneers invites all telephone pioneer ham radio operators in the United States and Canada to participate in contacting as many individual members as possible and to reach members in as many different chapters as possible.

The QSO party will start at 1900 hours GMT, Saturday, December 5, 1970, and will end at 0500 hours GMT on Monday, December 7, 1970. All bands may be used and the same station may be worked on more than one band.

Phone User: Call "CQ Telephone Pioneers."

CW User: Call "CQTP"

Score one point for signal report exchange with a Pioneer in any chapter, and one point for exchanging reports with each different chapter.

Send log extract showing date, time, station worked, chapter name and number and contact number, not later than January 5, 1971 to:

Frank J. Wojcik W2SNJ
Stanley S. Holmes Chapter
Telephone Pioneers of America
100 Central Avenue
Keaney, New Jersey 07032

Swap Shop

Monroe County Radio Communications Association announces a Swap & Shop on M-50, 4 miles west of Monroe, Mich. Oct. 11, from 10 a.m. to 4 p.m. Doors open at 8 a.m.

multiplier of 1.25 for all transmitters running 150W CW, 150W AM, 300W PEP, and under.

Each Trillium station may be contacted twice. For example; one fone contact and one CW contact (same band), or two fone contacts (different band), or two CW contacts (different band). No cross band or cross mode operation allowed. CW contacts must be made below 3.725, 7.150, and 14.100.

Logs must show: date, time in GMT, RST, band and mode, TOT number, as well as name and address and claimed score. All logs must be signed by the operator.

Nonmember with the highest score will receive a Trillium Plaque. Each participant who submits a log (one contact will qualify) will be eligible for a lucky draw.

The TOT gals will operate all frequencies and modes on 80, 40, and 20 meters during contest time. If you can't find them, check the following net controlled frequencies. There will also be a mystery station in operation. Working the mystery station will give you 10 bonus points.

Frequency	Date	Time (GMT)
3.855	Nov. 21	0300*
3.685	Nov. 21	0200**
7.240	Nov. 21	1300
7.103	Nov. 21	1430
14.280	Nov. 21	1830
14.140	Nov. 21	2000
14.035	Nov. 21	2130

*7:30 p.m. EST Nov. 20)
**9:00 p.m. EST Nov. 20

Send logs to Betty Peterson VE3ASZ, 19 Innismore Cres., Scarboro, Ontario, Canada. Logs must be postmarked not later than December 31, 1970, and received not later than January 15, 1971.

Roanoke Division Director, and league officials from headquarters.

A flea market will be conducted all day Saturday with a CW contest, a homebrew contest, and a QSL Card contest on Sunday morning.

Highlight of the convention will be the banquet to be held on Saturday night featuring a well known and very entertaining speaker. Climaxing Saturday's activities, cerimonies of the Royal Order of the Wouff Houng, the amateur secret society of the ARRL, will be held at midnight.

Latest radio gear and related equipment from several manufacturers will be on display at convention headquarters during the day Saturday.

Girls, we haven't forgotten you. The XYLs are planning a fantastic luncheon, complete with speaker and mementos of your visit, followed by a shopping spree in Raleigh's modern North Hills Shopping Center, a completely enclosed. all weather center with inside access to all stores. Transportation will be provided to and from the Shopping Center. There will be a ladies hospitality room on Saturday for your entertainment with coffee, snacks, and a presentation by Merle Norman Cosmetics. In addition, a suite of rooms has been reserved just for the girls so you can freshen up, prop up your feet, straighten your seams, etc. Cost of the luncheon and transportation for the shopping spree is $3.50 for pre-registration or $3.75 at the time of the convention.

Convention headquarters is the Statler Hilton Inn, located at 1707 Hillsborough Street in Raleigh, just a short drive from all major highways into Raleigh.

While pre-registration is scheduled to close on October 20, registrations will be available at the time of the convention. Pre-registration will be

contact and multiply by the number of states, provinces, or countries. Out of state stations use the number of different countries worked for the multiplier. Awards: Certificates will go to the first place winner in each state, province, or country and first place in Indiana counties. A special award will be given to the highest scoring station in and out of state. The mailing deadline is December 31, 1970. Send your log to Contest Chairman, Thomas J. Thamann, WA9MXG, 5013 Nowland Ave., Indianapolis, Indiana 46201. For results please include SASE.

Book Review --

The Fifth Edition of SINGLE SIDEBAND FOR THE RADIO AMATEUR has been revised to include some up-to-date theory and practice. With a great deal of new material, a new emphasis has been placed on the application of solid-state devices in sideband radio equipment.

Among the thirty-odd articles (reprinted from QST) are those describing station accessories, receivers, phasing and crystal-filter SSB exciters, sideband transceivers and transverters, plus five linear amplifiers. One new entry is a solid-state transceiver covering the 80–10 meter amateur bands plus a communications receiver using phase-lock techniques.

73's evaluation: A useful book for the sincere SSB enthusiast with a penchant for building. But don't expect transistors and ICs on every page. The book is basically last year's model jazzed up with semiconductor circuits sprinkled sparsely hither and thither.

Donations $1.25 in advance, $1.50 at the door. Prizes, auction, free parking, many contests. Talk in: 146.94, 52.525, 50.4, 3.930.

RSO CONVENTION

The Windsor Amateur Radio Club will be hosting the annual Radio Society of Ontario (RSO) convention 1970 this coming October 23–24th.

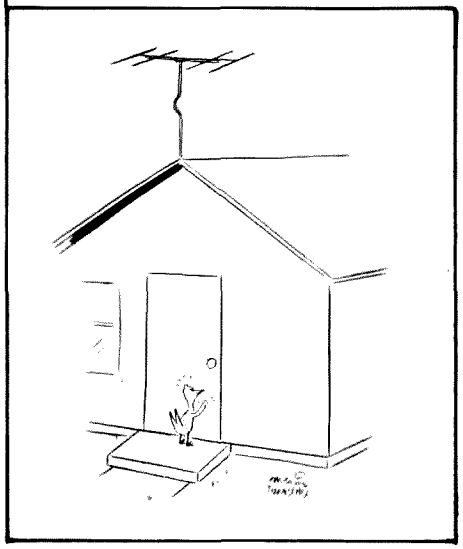
Date: October 23–24, 1970 (Fri. & Sat.)

Place: Holiday Inn, Riverside Drive, Windsor, Ontario, Canada. (Across the river from Detroit, Mich.)

Registration: OM, $4; YL, $3; Students, $2.

Talk-in stations on 75 and 146.94 FM. Programs for the ladies. Door prizes. Manufacturers' displays, etc.

Tentative forums include RSO, antennas, amateur TV, FM, servicing and homebrew, RTTY, solid state, and more.



Inter-Regional Allocations Changed By FCC

Parts 2, Table of Frequency Allocations, and 97, Amateur Radio Service, have been amended to incorporate the provisions of Nos. 117 and 156, and Resolution No. 10 of the 1959 Geneva International Radio Regulations for international contacts by amateurs in the 7000–7300 kHz band. The amendments become effective October 9, 1970.

In No. 156 (Table of Frequency Allocations – 10 kHz to 40 GHz) the 7000–7100 kHz band is allocated exclusively to the amateur service on a worldwide basis. The 7100–7300 kHz band is allocated in Regions 1 and 3 to the broadcasting service and in Region 2 (Western Hemisphere) to the amateur service. No. 117 requires that stations of one service in one region must not cause harmful interference to stations of another service in the other region or regions. Resolution No. 10 provides that inter-regional amateur contacts should be only in the 7000–7100 kHz band and that administrations should make every effort to see that the broadcasting service in the 7100–7300 kHz band in Regions 1 and 3 cause no interference to the amateur service in Region 2.

In its order, the FCC listed a seven-point rule change, as follows:

1. Among the International Radio Regulations adopted as a result of the Ordinary Administrative Radio Conference, Geneva, 1959, are Numbers 117 and 156. In No. 156, which incorporates the Table of Frequency Allocations – 10 kHz to 40 GHz, the band Regions or sub-Regions, a band of frequencies is allocated to different services having equal priority, the basic principle is the equality of right to operate. Therefore, stations of one service in one Region must operate so as not to cause harmful interference to stations of another service in the other Region or Regions.

2. Resolution No. 10 gives additional force and effect to Numbers 117 and 156, as they apply to the Amateur and Broadcasting Services. It resolves that inter-Regional amateur contacts should be only in the band 7000–7100 kHz and that administrations should make every effort to ensure that the Broadcasting Service in the band 7100–7300 kHz, in Regions 1 and 3, does not cause interference to the Amateur Service in Region 2.

3. To reflect these provisions in the Commission's Rules and Regulations, Part 2, Section 2.106, the Table of Frequency Allocations, is amended, and a new NG62 footnote is added following the Table.

4. Likewise, Section 97.61 is amended to delete the current "limitation (3)" as it now reads and to modify "limitation (4)." The new "limitation (3)" and "limitation (4)" incorporate the provisions of Numbers 117, 156, and the new footnote NG62 after the listing of the 3800–4000 kHz frequency band and after all of the listings of the 7000–7300 kHz band in the chart. Appendix 2 to Part 97 is also amended to include the text of Resolution No. 10.

CHANNELIZING MADE FREE SERVICE TO CHICAGO AREA FM HAMS

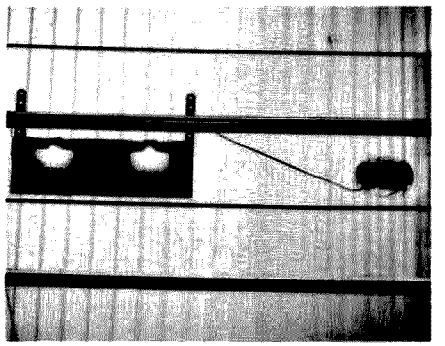
The people at Spectronics Inc., of Oak Park, Illinois, have initiated a unique little service that should prove appealing to the local 2 meter FM crowd. They have installed a well calibrated FM receiver in the store and connected two large easy-to-read meters – one to monitor deviation level and the other to indicate frequency.

They installed the meters near the front window of their store so that FM'ers can pull up in their mobiles and get accurate readouts of the two most critical transmit characteristics.

Art Housholder, manager of the firm, said the receiver in the store was always left on anyway, so why not allow it to be used by Spectronics customers as a standard?

Apparently, Spectronics' 2 meter FM customers approve of the idea, because there always seems to be a lineup of vehicles outside the window. It's kind of a drag, though, some customers complain. Parking is at a premium in the neighborhood, anyway; and local hams kind of feel guilty parking out fron and blocking the view when they're dropping in for no better reason than to buy something.

As one local puts it, "There's so many people coming and going that you really can't feel comfortable overhauling your rig out front unless you do it at 3 a.m.





Customers of Spectronics (near Chicago) can get their mobile FM units shaped up if they do it in front of the store. In the window are large meters to indicate frequency and deviation of strong signals.

7000–7100 kHz is allocated on a worldwide basis exclusively to the Amateur Service and the band 7100–7300 kHz is allocated in Regions 1 and 3 to the Broadcasting Service and that where, in adjacent

FCC Violators Get More Than Warnings

The FCC continues its crackdown on violations, and is toughening its bite, as the following actions will attest.

August 27 – JOHN W. SATTERTHWAITE, III, FAYETTEVILLE, N.C., licensee of amateur radio station WB4FOS. Ordered the license revoked, effective October 6, for repeated violation of Section 1.89 of the Rules by failing to reply to official communications (SS-302-70).

August 28 – MARTIN C. HIGGINS, LA CRESCENTA, CALIF., licensee of amateur radio station WA6AGX. Ordered the license revoked, effective October 7, for repeated violation of Section 308(b) of the Communications Act of 1934, as amended, and Section 1.89 of the Rules by failing to reply to official communications requesting information (SS-290-70).

September 3 – STEVE M. FRIED, BROOKLYN, NEW YORK, licensee of amateur radio station K2PTS. Ordered to show cause why the license should not be revoked for repeated violation of Section 1.89 of the Rules by failing to reply to official communications (SS-054-71).

GETTYSBURG OFFICE EXAMS TERMINATED

Effective September 4, 1970, amateur operator examinations will no longer be given at the FCC's Gettysburg, Pa., office. Alternate locations for examinations will be available at the Commission's offices at Balitmore, Md., Washington, D.C., and Philadelphia, Pa.

DOCTORS HONORED

At the recent annual meeting in Chicago of the Medical Amateur Radio Council, Ltd., six physician hams were awarded certificates of merit for service to the world via amateur radio.

Those honored were all MARCO members.

The Medical net meets every day on 7260 kHz at 0100 GMT, and 14.280 MHz at 0200 GMT for phone traffic, and on CW at 7060 kHz at 0230 and 14.060 MHz at 0230 GMT; the former on Mondays, the latter on Fridays.

The council is a charitable and scientific membership corporation to meet medical–electronic and radio communication needs. Its purpose is to establish personal communication among its members and their ham colleagues for dissemination of factual medical, electronics, and communication information both theoretical and practical. MARCO has members throughout the world who are either doctors of medicine, dentistry, veterinary medicine, or of other allied sciences. It also has other associate and affiliate members who are medical students, pharmacists, registered nurses, or in other allied medical professions.

First Modulated GaAs Injection Laser?

Ralph Campbell (W4KAE), of Lexington, Ky., announces that he has successfully modulated and detected an injection laser made of gallium arsenide. His equipment consists of an RCA TA-7610, whose nominal peak output is 10W operating on a wavelength of 9050 angstroms.

Pulse repetition rate was 8 kHz; transmitting optics an F/1.2 zoom projection lens, frequency modulated by voice and a Sonalert singing signal. The receiver was a United Detector Technology type PIN-6LC with CA-3035 integrated circuit (modified for video bandwidths) and a one-shot multivibrator for FM detection. Although previous range limit was 2.4 miles with a pulsed 7W (peak) unit, expected range of the newly developed equipment is up to 20 miles line-of-sight, with photomultipliers. Schottky-barrier photodiodes and FF600 fotofets are recommended for solid-state detection. Campbell is writing a book on gallium arsenide injection lasers, for publication in 1971.

Ham Auction

The Chicago Amateur Radio Club, W9CAF, will hold a ham auction on Sunday, October 25, 1970. Location is St. Viator Hall, 3608 N. Kedvale (3 p.m.). For info call CO-7-3724 or KI-5-3622.

EXPO 71

According to the latest Amateur Call Book, the number of new licenses has gone down in the past few years. The main theme of the Expo 71 exhibition will be to reawaken the interest in both the amateur in his hobby and also those of the public leaning in that direction.

Expo 71 will be a family affair, with a Kiddy Ride Park and Indian Village for the kids. A trailer camper area, and restaurant on the park site.

AMERICAN RADIO CLUB REGIONS

Charter applications have been received from several groups in response to the article on page one of the August Amateur Radio News Page of 73.

In the works are charter petitions from the following groups:

Lone Star Region (Houston, Texas)

Lincoln Trail Region (Urbana, Illinois)

Swampland Region (Metarie, Louisiana)

Gold Coast Region (Miami, Florida)

The American Radio Club will accept bids from groups of radio amateurs interested in establishing Chartered Regions of the Club. Send a list of the founding members (five or more), the area included in the Chartered Region and the name of the proposed Region to the American Radio Club, % 73 Magazine, Peterborough, N.H. 03458.

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. Include your check with order.

Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

For $1 extra we can maintain a reply box for you.

We cannot check into each advertiser, so Caveat Emptor. . .

SOLID STATE VOM for sale. Triplett 601. Brand new, never used. Net $150, first $100 takes it. Prepaid. K. Grinde, 536 W. Hillsdale, Inglewood CA.

TOLEDO MOBILE RADIO ASSOCIATION'S 16th annual hamfest and auction will be held February 21, 1971, Lucas County Recreation Center, Maumee, Ohio. $1.00 registration. Open table sales. Map and info write: TMRA W8HHF, Box 273, Toledo OH 43601.

WANTED: Computer core memory. Send description and price wanted to: John Clements, 1125 Pacific St., Apt. 1, Bremerton WA 98310.

DRAGON FLY . . .antenna, for 20-40-75 meters . . .no traps . . .no compromise . . .eight months in development . . .one feed line . . .SWR one to one guaranteed. Construction drawings $5.00. Box 423, Wakefield RI 02880.

RBB-RBC MANUALS, New, $5.00; Used, $4.00. OS-8 oscilloscope manual, $3.00. Some QST 1929, 30, 31, etc. Radio 1939, 40, 41, etc. Write for list. James W. Holloway W6LFL, 2027 Harton Rd., San Diego CA 92123.

SELL: SX-100, speaker $110; Valliant $100; Apache $75; SB-10 $45. WANTED: AR-22 Rotor control. Bob Miller WA6MTY, 1377 Newport, Long Beach CA 90804.

HEATH HW-32-A, almost new; HP-13 supply, mike, and Newtronics mobile antenna — all for $110.00. Will ship: WA4TST, 507 Pinecone, Waycross GA 31501.

CHARTER JET FLIGHT to SAROC. Roundtrip New York City to Las Vegas $229.00, depart JFK 10:00 a.m. January 7th. Roundtrip Chicago to Las Vegas $199.00, depart O'Hare 12:00 noon January 7th. Return January 10th. Includes meals and drinks aloft, Flamingo Hotel Room three nights double occupancy, transportation and baggage in and out of Flamingo Hotel, dinner show, midnight show, Saturday buffet luncheon, Sunday buffet breakfast, SAROC tickets, tax and gratuity. $60.00 will confirm reservation, includes one dollar service fee. Final payment due before November 25th. Flight cancellation or written request for deposit refund will be accepted until December 1st. SAROC, Box 73, Boulder City NV 89005.

INSENSED AT INCENTIVE LICENSING? You and your club can actually do something about it. Send for free petition requesting incentive licensing apply only to ARRL members since ARRL proposed the changes. Send SASE to Committee to Preserve Amateur Radio, Box 99, Annapolis Junction MD 20701.

SALE: Pick up W2BDS "Big Bertha" plus rotator system, stacked 20m 646X, stacked 15m 532X, stacked 10m 523X, complete with phasing lines, remote controlled 8 pos. coax switch plus 40m 329X. Not everyone can afford, but — if you have desire and "mon" — come — take it away. Only $9,495.22 offered by M.D. Ercolino (201) 775-7254 before noon or (201) 531-4990 afternoon.

SB101 and **HP23A**. Factory aligned 8/69. Package with Turner 454X, bug, Heath swr bridge. Complete station, excellent condition; $275. WA2EWK, Kitchell Road, Convent NJ 07961.

SELL: Gonset G-76 transceiver 80 through 6 with ac/dc supplies, $195.00. WANTED: Collins 312B4. State price and condition. W7TMF, 1254 Heather Lane SE, Salem OR 97302.

FOR SALE CAP transceiver Heath HW-18-1 4602.5 and 4630 kHz. Assembled and tested never used. Insured and shipped for $120.00. J.D. Clowdus, Box 73, Springer OK 73458.

SUCCESSFUL HAMS invest in W6SAI Handbooks for top-man results! Cubical Quad Handbook, $3.95; Beam Antenna Handbook, $4.95; VHF Handbook, $3.95; Better Shortwave Reception, $3.95; Electronic Construction Practices, $3.95. Sold by leading ham dealers. On orders to publisher, please add 20¢ per book for handling/postage. Radio Publications, Inc., Box 149-C, Wilton CT 06897.

COLOR ORGAN KITS $7.50. IC power supplies $2.75 to $8.50. Computer grade electrolytic capacitors $.35. Xmtr transistor TRW PT3690 $2. Used variacs. Nuvistors. Catalog. Murphy, 204 Roslyn Ave., Carle Place NY 11514.

DERRICK ELECTRONICS will not be undersold on new Swan equipment. We'll beat any legitimate deal. Check around, then write. 108 East El Paso, Broken Arrow OK 74012.

WANTED! Numerous back issues of different radio magazines. Huge Free List. Trading old radio shows, airchecks, interested in commercial movie material. Thomas King, Auxier KY.

ROCHESTER, N.Y. will again be headquarters for the huge W.N.Y. Hamfest, VHF Conference and Flea Market, May 15, 1970.

Editorial:
An Old Timer Looks At The League

by George Brook Taylor W4PZS

Many of us feel deluded and disappointed in the way our hobby has been going the past few years . . .the League and its dictatorial policy toward its membership and its incompetent direction . . .the FCC for blindly accepting an injudicious proposal made by the League, that has resulted in the chopping up and cally motivated it cannot without bias represent its membership or the other U.S. amateurs in Washington.

Censorship in QST is enforced as in a military operation. Check it out. Write a clear sensible letter in opposition to one of their proposals, explain in careful detail why it will be detrimental, unworkable, or unfair. It will *never* be published! The membership has to be composed of Yes Men. If you want to get along in the League

REGENCY SCANNERS: Hi-band 8-channel $105, low-band 8-channel $109. With all accessories. Excellent condition. R. Coburn, PO Box 92, Manchester NH 03105.

SALE: Autronic keyer, key. Brand new condx; value $79.50, $19.95. Best offer by 15 November takes both. Rev. Windolph W9NHO, Quincy College, Quincy IL 62301.

RED HOT! 5RK Delta tri-bander — sensational break through in Delta Loop design. Proven outstanding DX ant. Highest quality — also heavy duty high performance quads. Check our low prices. Island Electronics, 4103 Ave. S, Galveston TX 77550.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class License, plus "Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

GONSETT COMMUNICATOR II for 2 meters. Asking $65.00 plus shipping. Sound electrically and physically. Edward Van Hise, 50 Gardenview Terrace, Apt. 9, Hightstown NJ 08520.

TRADE, SELL: SP-600-JX General Coverage Receiver (vfo & crystalled channels) for FM base station usable as repeater. O.C. Powell, 214 Chandler Rd., Goldsboro NC 27530.

ALLIED 5-band SSB transceiver and ac supply, A2517/2518 (reg. $450), new, only $325. R4B, new, $375. Sochor, 419 S. Euclid, Oak Park IL 60302.

BUY, TRADE, SELL: Used amateur receivers. Steven Kullmer, Evergreen Hatchery, Dysart IA 52224.

WANT TO buy or trade for 1-177 tube checker. D. Plotter, 2844 San Gabriel, Austin TX 70802.

WANTED: Receivers for 160 and 2m. Examples: Ameco All Wave Rx; Allied A-2515; etc. W2SPB, 1325 Laurel Ave., Ocean NJ 07712.

SELL: Two Synchro tape machines (Remington Typewriter/Friden Tape/Card Punch and Reader) $150. Operation instructions and manuals for Friden units only. Some tape and cards included. Complete description in late 1968 issues of 73. Tektronix 511AD $95. Tektronix 514AD $150. Manuals, probes, and some spare tubes included. Richard E. Lee, 660 Poinsettia Ave., Titusville FL 32780.

TELETYPE PICTURES FOR SALE: Volume 2, 16 pages containing 50 pictures $2.00. Volume 3 coming $1.50. Also audio and perforated tapes. W9DGV-c, 2210-30th St., Rock Island IL 61201.

NOVICE CRYSTALS: 40—15m $1.38; 80m $1.83. Free Flyer. Nat Stinnette Electronics, Umatilla FL 32784.

GREENE . . . center dipole insulator with . . .or . . .without balun . . .see November 73, page 107.

SAROC January 7—10, 1971. Flamingo Hotel Convention Center, Las Vegas, Nevada. Sponsored by Southern Nevada ARC, Inc., Box 73, Boulder City, Nevada. Advance registration $14.50 per person accepted until January 4, regular registration at door, includes Flamingo Hotel Late Show and drinks, Sunday breakfast, cocktail parties, technical seminars and meetings, ARRL, DX, FM, MARS, QCWA, WCARS-7255, WPSS-3952, and WSSBA. Ladies Program. Flamingo Hotel SAROC room rate $12.00 plus room tax, per night, single or double occupancy January 3 thru 12, 1971. Mail accommodations request to Flamingo Hotel. Mail advance registration to SAROC. W7PRM, Club President, SAROC Convention Chairman.

DTL INTEGRATED CIRCUITS: Guaranteed new — gates 70¢, buffers 80¢, F/F 90¢, dual F/F $1.15. Add 20¢ for postage. Also other inexpensive parts. Lists & prices from Mitch-Lan Electronics Co., Dept. 1170, PO Box 4822, Panorama City CA 91412.

butchering of our already overcrowded bands. Yet, even with such catastrophic events we still have a wonderful hobby.

Much is heard today about the lack of growth of amateur radio. Incentive licensing undoubtedly accounts for this condition. After the League started this fiasco and caused widespread dissension in the amateur ranks, the hobby began to lose favor and attractiveness to the newcomer and many an oldtimer quit in disgust.

The FCC has proved by its actions it knows little about the amateur and his problems and cares even less. The amateur is indeed a second-class citizen as far as the FCC is concerned. Several independent polls showed amateurs to be overwhelmingly against incentive licensing. The FCC received thousands of protest letters that did not adhere to their 14 copy rule. The 14 copy rule may be necessary and correct for the application for a formal rule change. It should *not* apply to all correspondence, such as an expression of views by the individual licensee to the FCC. These should be given full consideration. Obviously they were ignored. This 14 copy FCC red tape should be cut.

A quarter of a million licensees should have representation on the FCC board. The FCC should revoke incentive licensing immediately. It is an unnecessary expense to the heavily overburdened taxpayer. It is wasteful use of the time of the FCC examiners when its *only* accomplishment is to inflate the ego of the licensee.

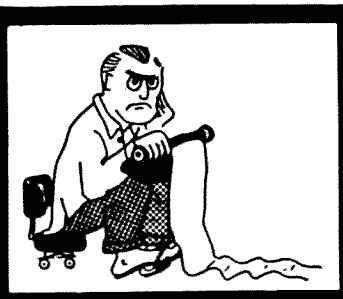
The League has proved its ineffectiveness to the U.S. amateurs in its refusal to open a Washington bureau and register as a lobby. We know the reason – they are afraid they may lose some of their government tax and mailing privileges they now unjustly enjoy. The League is so politi- you do what you are told.

Vote a good regional director into office. He starts making noise, adding up figures, asking embarrassing questions, opening closed doors, and he soon finds himself on the outside. You hear about the secret prior meetings, the demands, the deals, the instructions to the directors.

A few years ago the League made much about what a big annual million-dollar operation their publishing business had become; then a few months later, when they decided to solicit contributions and gifts for their new building, they suddenly became the poor-boy, never again was their big business mentioned or a financial report printed on their pages. You did find many bouquets, sweet bouquets scattered throughout telling how wonderful is the League. They harp endlessly how everyone that is not a member or a contributor to the building fund is a free-loader. The *League* is the *real* free-loader. They have been free-loading their writers and the U.S. taxpayers for years.

The League should *reform*, have its house thoroughly cleaned, and free itself of government subsidies and special benefits. Only then can it properly function and be a democratic organization fit to properly represent the U.S. amateur radio operators.

Until 1964 I wore my ARRL lapel pin with pride; but after that I became so ashamed of the League I removed it. To show the League my disgust for several years when I sent in my annual dues I asked for it to be a subscription to the magazine only as I no longer desired membership. Finally, in October 1967 when the FCC gratified the League by enacting the incentive licensing thing, that was for me the death certificate of the ARRL and QST.



NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

In this day of women's liberation movements perhaps we should examine our attitude toward our wives. Perhaps not. As long as they hold their jobs, bring home enough money to help buy a new rig now and then, bring the meals into the shack between schedules and don't plan nights out during contests, maybe we should agree with them.

A woman is as good at some jobs as a man any day. She is better at many. And if she is as good, why shouldn't she be paid just as much. Particularly if she is your wife.

Of course if you are the employer, then your perspective may be biased and you may have a poor attitude toward the argument. Employers tend to cloud the basic issues with irrelevant factors in order to justify their own greed or even their own subconscious wish to dominate women.

For instance some employers will plead that it takes an employee about six months on the job, man or woman, before they know their work well enough to function efficiently. The six month training period can cost the employer plenty as the result of errors. One wrong ad in a magazine and $400 to $600 goes down the tubes . . . or more if the advertiser cancels $6000 worth of ads as a result. The employee is sorry and promises to do better.

Once trained, what are the differences between a man and a woman on the same job? Very little in many cases. Lots in others. The employer has nothing whatever to worry about as long as the woman has no children who can get sick and need care, has a husband that is not going to get a job elsewhere, and does not get pregnant.

You may find this hard to believe, but I personally know of a publisher in New Hampshire who has a women's lib wife and pays man-type salaries to his women employees. So far this year three of his highest paid employees, girls that he trained for many months, left the state because their husbands moved. This is a poor example of company loyalty, admittedly, for the employer is out who knows how many thousands of dollars. If he'd hired men for the jobs they might still be there. The publisher is left wondering whether the equal pay policy isn't awfully one-sided.

Is the solution unmarried girls? Not on your buttonhook, these gals will get married at the drop of a proposal to the first bum that offers to rescue them from that miserable sweatshop where they while away their coffeebreaks, extended lunches, and rest periods. Seriously, though, many gals do bring the same sense of dedication and enthusiasm to their work as a man, even though they may realize that their true goal is bringing up their family and keeping it happy.

Women's lib will get a big shot in the arm when the girls can come up with reasonable answers for those misguided employers who figure that women should be paid less because they bring in less in the long run. Should men stay home with the sick children half of the time? Should men change their jobs if the wife gets a better job in another city? Should we start working hard on some practical system for the men to have the babies, thus freeing women from morning sickness and the delivery room? Or perhaps we are getting ready to go back to the old system where the woman stops work for a few minutes, has her baby, and goes back to work. Are we mollycoddling our women too much with this free vacation in the hospital arrangement?

Hear! Hear!

One nice thing about driving in Europe is that you don't have to keep one eye always peeled for the fuzz. In the U.S., where speed limit signs are everywhere and the limits proclaimed often impractical and ignored, it behooves the driver to watch for radar, hidden patrol cars, and such.

My mind has been greatly eased by a new book, "Take Your Traffic Ticket To Court – And Win!" This book, written by a retired judge, should enable anyone to win just about any traffic ticket case. Why line up at the cashier's window and pay that fine? Do you take it for granted that the police always correctly interpret the vehicle code? Do you pay the fine to save time and trouble even when you know you're really not guilty? If you're shelling out more and enjoying it less, this book will help you to insure your legal rights.

(cont. on page 98)

Leaky Lines

AN EDITORIAL by DAVE MANN K2AGZ

1 DANIEL LANE, KINNELON NJ 07405

At first blush the "Hobby Class" license proposed in July's issue of 73 excited resistance on my part. I felt, as do many others, that we ought not to favor any class of license which would not have an accompanying hurdle of code and theory attached to it, so that there would be some means by which the unfit or otherwise unacceptable might be weeded out. And then I got to thinking seriously about it . . . I mean objectively; weighing the alternatives; trying to envision the results which might come about as a result. Although I would not have liked to admit it at first, I now feel constrained to state that I have changed my mind concerning the subject. And I will tell you why.

Recent actions relating to the amateur service do not indicate any marked inclination on the part of FCC to consider our problems as seriously as it considers its own. Their principal action, which was supposedly implemented for the best interests of amateur radio, that is, incentive licensing, was brought about as a result of ARRL suggestions. The change did not originate with the Commission. Or, if it did, way back in the past, it was kept alive by ARRL, which the FCC regards as the spokesman for all hams. Most of their other actions; creation of Citizens Band, raising fees for licenses and renewals . . . these and others are indicative of the fact that we are hardly at the top of FCC's list of priorities. We have sometimes noticed an apparent unwillingness to crack down hard on violators of FCC regulations who happen to be nonhams, particularly CB'ers and commercial intruders into our spectrum. Such persistent flouters of the laws have not only gotten away with their illegalities, they continue unabated.

It is clear that the FCC, understaffed and underfunded, is far too busy with commercial radio, television, telephone, communications satellites, radioteletype, wire services, and others, to be able to devote themselves more than casually to the ham bands. That is why we must continue our policy of self-policing. That is why we must devise and suggest the changes that will improve our condition in the scheme of things. If the Commission, sometimes all too prone to reject wise suggestions in favor of unwise ones, is too busy and harassed to find avenues for our growth, then we ourselves must do so.

The effects of the presently constituted Citizen Band allocation are too well known to have to be recapitulated here. Those for whom this service was originally created have not been able to make full use of it, due to excessive misuse by hobby-oriented persons seeking an outlet for their repressed energies, but unwilling to devote any study or thought to obtaining amateur licenses. There have been some efforts among the CB'ers themselves to halt this travesty . . . to build a nationwide organization similar to ARRL, so that all quasi-ham activities in CB . . . civil defense, fire watch, road patrolling, small boat safety, etc., might be coordinated in a constructive fashion. They are aware that this is the only way in which a program of self-policing, such as our own, can minimize the numbers of inveterate violators in their ranks. These efforts have not been notably successful. To be sure, there are clubs and associations, such as REACT, which are currently trying. But the deliberate violators constitute such a staggering percentage, that it is unrealistic to expect REACT and others to be sufficiently broad-based that a significant dent can be made.

In many instances we amateurs are blamed for interference which originates with this illegal CB operation. We have had to face indignant neighbors, demanding a cessation of our legitimate activity, when the true culprits have been local CB hobbyists. Since we are visible in our communities, operating openly, and since TV repairmen are notorious sometimes for attributing reception difficulties to the "ham with the big antenna tower in the next block," the problems continue unabated, and we must constantly deal with repeated efforts to limit amateur radio, while the 27 MHz lunacy goes on and on and on, like a communicable disease, unchecked.

The creation of this hobby license would effectively lessen these irritating conditions. It would open a viable source of income to the manufacturers of radio equipment, and would undoubtedly result in higher pay envelopes for many of the hams who are employed in the electronics industry. It would provide a large source of additional revenue to the FCC. It would assist greatly in the development of new VHF techniques. It would liberate 27 MHz for the legitimate use of those whose livelihood may

(cont. on page 96)



Death of a Rig

We should be ashamed. All of us. The ham fraternity has collectively brought sufficient pressure to bear on one of our most reputable manufacturers that a fresh and necessary unit of exceptional design was dropped. The manufacturer – Swan Electronics – will lose money because of tooling and design expenses that will never be recouped. The amateurs lose because they'll not get the benefit of a truly great transceiver design approach. And all because a few ham do-gooders jumped to some irrational conclusions.

But let me start from the beginning: Engineering thinkers at Swan had noted the lack of activity on 10 meters and put their heads together to see what they could do about it. Here's what they learned: When 10 meters is open for comparatively long periods, the band gets progressively more populated.

It seems obvious that amateurs enjoy working 10 meters, but not many people monitor enough to know when the band is open and when it is not. As a consequence, many openings come and go witnout hams around to take advantage of them. What 10 meters needs, Swan said, is a surefire and quick method of knowing when 10 is usable for DX.

One excellent solution was the one adopted by Swan – simply incorporate an 11-meter receive capability in a 10-meter transceiver. With all the nearly constant signals on the 11-meter CB channels, an opening could be detected there almost instantly. Then the operator need but fire up the 10-meter transmitter (which won't work on 11, by the way) and put out a call.

With enough hams using the system, everyone benefits: 10 gets active, openings no longer go unnoticed, and another dying band gains renewed popularity.

A good idea? At 73, we thought so. But there were a handful of loudmouths who didn't. They wrote to Swan. They wrote to the FCC. They wrote to the ham journals, including 73, where their comments were filed where they belong – in the wastebasket.

Their complaint? Swan's new transceiver (No. 1011) can transmit and receive on 10 meters, but they feel its "receive only" capability for 11 meters would encourage CB'ers to buy and modify for illegal operation on the CB channels.

It apparently didn't occur to the whiners that any linear that will operate on 10 will operate on 11 meters; that many manufacturers – including a few "respectable" ham manufacturers are actually building and selling high-power linears *exclusively for* the CB channels. They didn't take note of the fact that virtually any transceiver that operates on 10 can be made to operate on 11. Such facts eluded them. All they could see was an 11-meter receive capability built into a 10-meter transceiver – and that was enough to get them going.

As editor of 73, I'd like to put in my two cents worth: First, the ham radio field is not a lucrative market. Manufacturers are – as often as not – in this aspect of the business because of personal management ties to amateur radio. Partially for this reason we amateurs should do our best to encourage and support these manufacturers (whose profit margins are far too narrow considering the engineering, development, and marketing efforts that must be expended for every item produced).

Second, I consider it blue-sky speculation for any amateur or group to assume that any manufacturer's products are going to be used for any purpose other than that for which they were designed. Take the case of the Swan 1011, for example. There seems to be three possible misapplications: (1) CB'ers could conceivably buy the transceiver and modify it for 11-meter transmit operation; (2) CB'ers could conceivably buy the unit and use it for illegal operation on 10 meters; (3) hams could buy it and use it for unlicensed operation on 11 meters.

From my experience in the CB field (I am also editor of a national CB magazine), I feel it is safe to say that not one CB'er in two hundred has the technical capability to successfully complete the necessary transmitter modifications – which takes care of item (1).

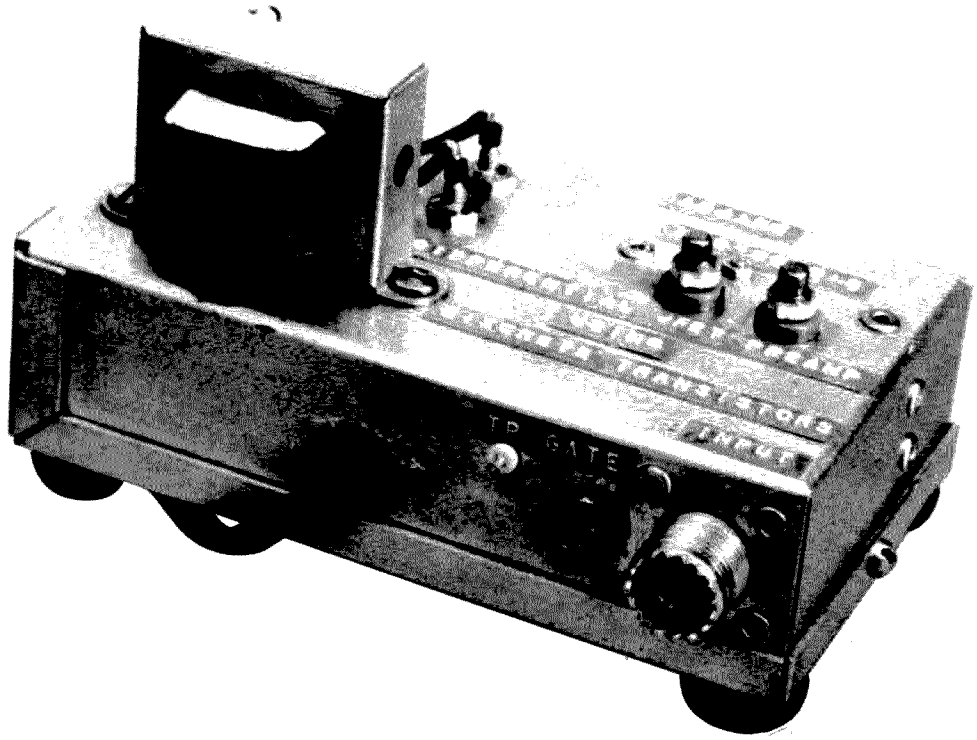
As far as item (2) is concerned, I believe that there aren't many CB'ers who are interested in joining us hams on 10 meters. I see every action notice that follows up an FCC violation, and do not remember a single case in the past 10 months where a CB'er has been nailed for operating on the ham band. Some CB'ers operate DX illegally; some use "skip" names instead of assigned calls; some run high power; some ragchew illegally; some have unlawful antenna setups. But there is no indication that any of them are infiltrating the ham bands.

Item (3) should speak for itself; how many amateurs do you know who would go out of their way to bootleg on CB? Enough said.

But the damage has been done. Swan only recently announced the 1011 addition to its line. Now, just weeks later, the addition is canceled. Swan's letter to ham dealers reads:

> For the first time in our history we have introduced a new model transceiver that has met with the disapproval of a number of our radio amateur customers. Letters we have received indicate a serious concern that the 1011 will be operated on the 10 meter band by CB'ers or other unlicensed

(cont. on page 97)



DIFFERENTIAL J-FET PREAMPLIFIER

Ralph W. Campbell W4KAE
316 Mariemont Drive
Lexington KY 40505

How about trying a J-FET (usually pronounced "jay-fet") preamplifier using discrete transistors, in the *differential* configuration? "Differential" is circuitry best known through work with integrated circuits; but there is no reason why we can't use "discretes" to achieve the results we seek. The amplifier presented here is the result of searching through various amateur and professional publications for the lowest-noise solid-state circuit – revealing little "new" – except for this mode of operation.

I turned to RCA's IC-41 linear integrated circuit manual for comparison of various bipolar IC hookups; the RCA CA-3028 looked most interesting, so I then chose Motorola's MFE-2000 as a discrete J-FET replacement. The RCA CA-3028 boasted 0.5 dB better noise figure in the differential mode, as compared with the cascode circuit. Hopefully, a similar "edge" in performance should exist with the J-FETs. The interesting thing about this new circuitry is that one semiconductor is in an "idling" position, while the other device does the amplifying! This results in two advantages: (1) The high-gain transistor (which may oscillate) can be made the

idler; or even a lower-gain, cheaper J-FET with the same noise figure can be plugged in; and (2) noise reduction with balanced, push-pull input, is achieved. Junction field-effect transistors (J-FETs) have further advantages, such as superior resistance to overloading, wide dynamic range with the higher drain voltages, and ease of input matching.

With exception of low-noise multiple devices (two J-FETs diffused on a single chip) these discrete transistors solved noise problems readily apparent to the ear. After listening tests, the 2 meter noise reduction seems about 1 dB; however, as to actual noise figure (not with the gain provided), I would assume only 0.5 dB to be the real improvement.

Another advantage with the differential mode is that neutralization requirements are greatly reduced. A tee section decoupler stopped all tendency for oscillation, even when higher-gain MFE-2001s were substituted. With a spot noise figure of 1.6 dB typical, we have a great 2 meter preamplifier! While I don't do more than estimate noise figure and gain, it is true that attempts were made to use University of Kentucky measuring equipment, but it was not operational.

Theory

Design of the preamplifier is straightforward. Dc biasing is just like vacuum tubes, except the supply voltage is much lower. I followed WIDTY's *Field Effect Transistor Primer*, (73 Magazine, Dec. 1965), and I must admit both "experimenter" and "paper" design techniques were applied. To get going on the "paper" design, I used the normalized FET transfer curve presented in that article, and referred to Motorola's *Semiconductor Data Book*, 3rd Edition, to determine pinchoff voltage V_P. Values given are 4.0V for V_P and 10 mA for I_{DSS}. With regard to Fig. 1, 10 mA and 6 mA are marked on the vertical axis for values of I_D; and the 0.6 ratio point is selected as described below. In case you've guessed 6 mA is the operating drain current!

Gate-to-source voltage is normalized or divided as with I_{DDS} and, since we have I_{DDS} set to be 10 mA and V_P at 4.0V, the loadline can be determined by dividing 4V by 10 mA, which works out to be 0.4 in normalized kilohms. The reason for using kilohms is that this saves time; and to check this scale plotting factor, simply extend the R_S=1 kΩ line until it intersects the upper right-hand coordinates.

The unknown ratios are now found. This is so easy that I used the "unknown" I_D/I_{DDS} ratio (above) by accident. Since we know the load line is to be 400Ω, it is drawn between the 300Ω and 500Ω lines already present on Fig. 1. (For clarity, I've extended the 400Ω line beyond the upper horizontal axis.) Now, where this line intersects the transfer curve (running parameter) we see a vertical and horizontal intercept at the 0.6 and 0.24 points for our ratios of I_D/I_{DSS} and V_{GS}/V_P, respectively. The use of this information can help the designer choose the operating point for any values up to 30 mA or 25V with the Motorola MFE-2000.

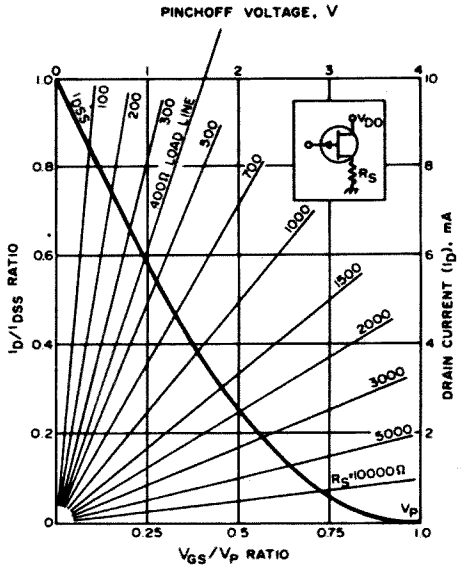


Fig. 1. Normalized FET transfer curves with typical operating parameters. Coils are: L1—2t 18 AWG, ¼ in. dia; L2—12t ct 18 AWG, ¼ in. dia; L3—10T 18 AWG bore, 3/16 in. dia; L4—2t 18 AWG (interwound), 3/16 in. dia.

Measurements

The operating point voltage was measured to be −1.2V, and operating

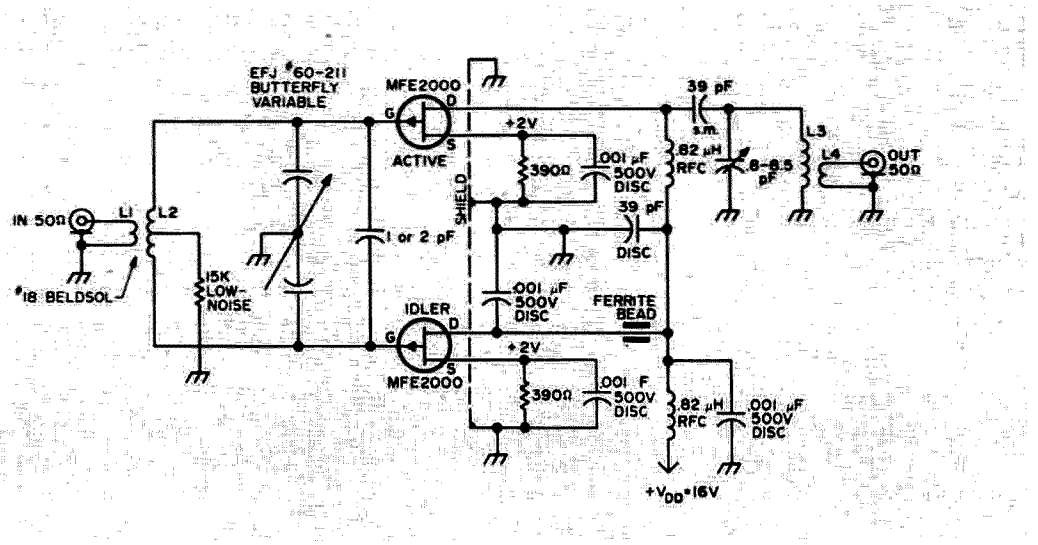


Fig. 2. Low noise J-Fet preamplifier for 2 meters.

current was measured at 5.5 mA. Gain of the J-FET differential preamplifier was found to be 3 S-units.

Choosing the gate-leak resistor was a matter of consulting the literature, where I found a circuit using TIS-88s (similar to 2N4416), which had a 27 kΩ gate return resistor. Having two MFE-2000s, I took about half-value for this resistance for both transistors operating in parallel.

Construction

The lead photo shows the top view of the differential J-FET preamplifier whose circuit appears in Fig. 2. This unit is built within an LMB 531EL endlock aluminum chassis. Note that each capacitor there is a large Ferroxcube ferrite bead (56-590-3B), which prevents man-made noise from entering the enclosure. The standoff on the side of the enclosure is the test point for drain-to-ground voltage checks. "Pop" rivets are seen in their use as interunit shield fasteners for the partition inside.

For the preamp, I used a 0.8–8.5 pF gold-plated piston capacitor. (The piston trimmer is shown in the closeups.) Other types of pistons having the same capacity and capacity range would work as well; however, the gold plating probably improves resettability and lowers rf surface ground losses.

Between the glass tank circuit and shield partition is the tee decoupling network, which is dc fed from the voltage doubler power supply. The common leg of the tee is resting on a 240 pF button bypass (value not critical), while to the right and left are the Miller molded, shielded 9240-707 rf chokes.

A feedthrough fitting is connected through the partition wall of the internal shield to the right-hand (single) drain connection; and the 39 pF silver-mica blocking capacitor rests against the chassis end plate. The shield partition tongue is bent to fit, and soldered onto the body of the partition. This makes a firm contact with the preamp bottom cover, when in place.

To the upper left of the shield is a piece of RG-174/U coaxial cable which connects to the test point.

A tubular ceramic capacitor across the variable capacitor (see closeup photo) provides signal resonance at the unmeshed position. The insures minimum noise characteristics, through the tuning range. The fixed capacitor should be to have a value within the operating range of the variable. This technique, by the way, also prevents false noise dips or peaks.

The power supply (Fig. 3) is a conventional full-wave voltage doubler with a trimming and surge resistor in series with the 6.3V secondary. Drain-to-source volt-

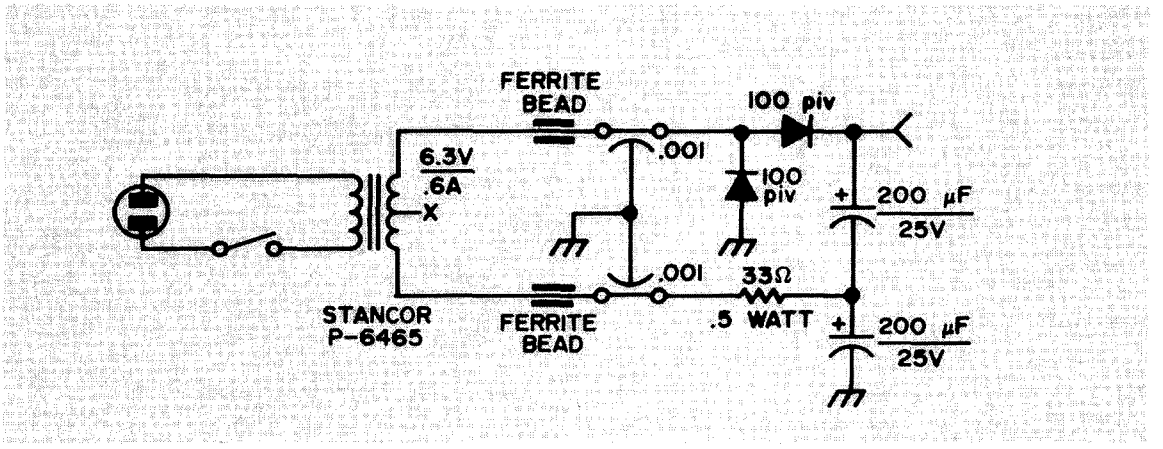


Fig. 3. Power Supply.

age "trimming" of the power supply is done with this surge resistor. Use of the tee should completely eliminate all oscillation.

Alignment & Adjustment

Noise figure estimating is always a curious business, since the variables involved depend upon usually inaccurate assumptions about generator impedance, signal level, and transmission line matching. One big problem was how to find a signal or noise dip. With a balanced differential input I found either a pair of dips at either end of the butterfly tuning range or a pair of peaks at these range ends. Between, I observed either a small peak or small dip, depending upon signal levels being fed to the preamp.

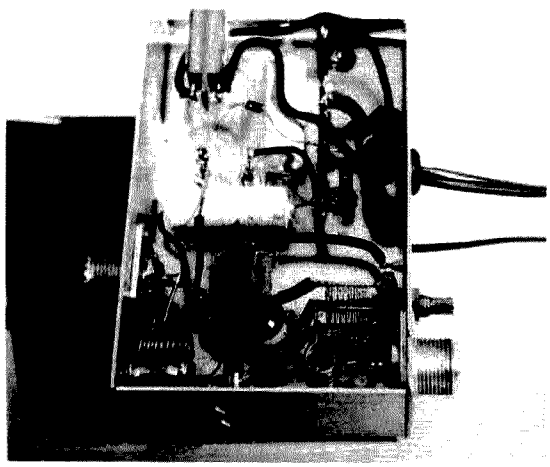
Before dipping and peaking adjustments were made, I used a Heathkit tunnel-dipper to place resonance at 144 MHz. This was with the input variable at the minimum capacity setting, the J-FETs in their sockets, drain and gate bias voltages present, and with the output piston capacitor adjusted for maximum capacity. Under these conditions, I realized the next thing to do was to load the balanced input tank circuit with 1–2 pF to keep the actual tuning range *below* resonance at signal frequencies, since lowest noise figure is always obtained this way. Strong signals (milliwatts) from my International Crystal 2 meter frequency standard resulted in two peaks at either end of the butterfly range, with a small dip in between. What this meant was that the J-FETs were absorbing several milliwatts of power at the crystal standard frequency, behaving like a generator and a load with the coaxial line voltage dropping between range-end peaks as conditions of maximum-power-transfer were approached. This doesn't mean the front-end input terminal was purely a resistance: The front end is probably matched to the resistance and reactance present; but the resistive condition, alone, is the load seen by the balanced tank circuit looking into the gate terminals. This procedure is the "strong-signal" method of obtaining lowest noise figure in the differential mode. Now here's another:

Most amateurs probably don't have a safe strong-signal source; so the weak-signal method is offered as an alternative. Using the Ameco TX-62 exciter, I found I could set the drive to minimum and, with the spotting switch, found it to be possible to send a weak signal (microwatts) into the differential J-FET preamplifier for noise adjustments. Of course, it is desirable to have the input fed from a terminated coaxial connector capacitively coupled through the open contacts of a Dow-Key SPDT relay. The termination used was a shielded CesCo PL-52 CB radio 5W dummy load. With the termination switched in and the desired weak signal from the Ameco exciter, I adjusted the capacitor for a peak between the two range-end dips. Confirming this as the low-noise point is easily checked by switching back and forth from dummy load to antenna (during a period of minimum band activity).

An explanation of circuit conditions would probably show that peaking occurred at the microwatt level, with the highly reactive generator coupling making the weak-signal source impedance appear very high. This would make any response other than resistive (matched at the gate terminals) immeasurable.

Operation

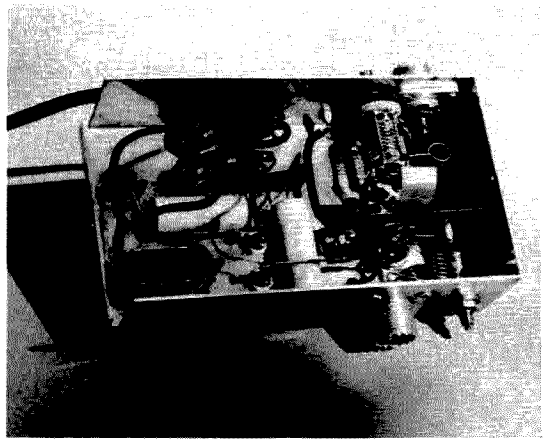
The differential J-FET preamplifier has been a pleasure to use. Not even locals overload my receiving equipment and the noise figure is so low I can hear transmission line noise (observed on incoming signals with separate antennas of about the same gain) when comparing RG-9 or RG-8 with a similar length of Aluminum Foamflex cable. I might add that without the



low-noise line, little can be achieved in "system" noise reduction, when dealing with the ever-present thermal agitation noise prevalent in most VHF gear.

The MFE-2000 J-FETs by Motorola showed very little tendency to oscillate using the differential amplifier configuration. I tried MFE-2001s, a higher-gain version, which did oscillate with one transistor of the pair chosen; however, the noise figure appeared to be the same.

Only one transistor is fully operative in the differential mode: but if you think the noise doesn't go up upon removal of the idling J-FET, just try removing it on a weak signal! Even a quick retune with a



single active FET will show more noise than with two.

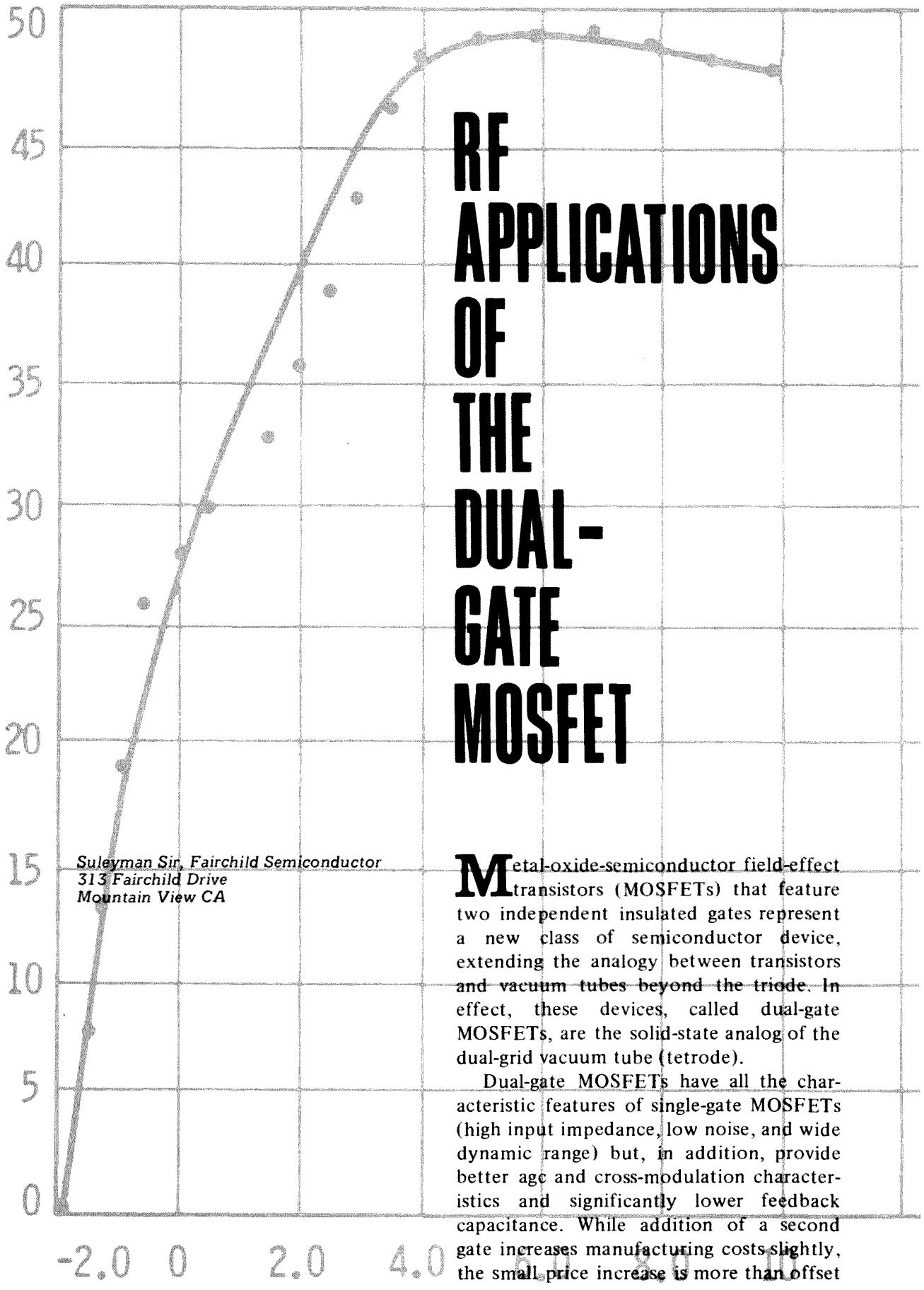
Use of the transfer curve brought out so clearly in W1DTY's primer should find extensive application in "power" FET work: For one thing, the normalized character of the curve can be altered to fit any device (including FETs like the CP-650 and CP-651, by Crystalonics) for operation in the power-gate region. For another, the curve can be force-fitted to suit both depletion and enhancement modes.

Conclusion

Regardless of how accurate a "paper" design is, always test the unit thoroughly in the laboratory before reconciling results with it. The "experimenter" method is always a valid check. Before building the unit described in this article, make sure you're using low-noise coax such as Amphenol 21-539 or Communications Products Aluminum Foamflex, or a very short length of the regular kind. The reason is that without the feedline having this characteristic, chances are you will not be able to notice "less noise" on incoming DX signals.

I would encourage others to try their hands at FET designs similar to this. And don't forget: If your receiving equipment doesn't use at least one three-lead semiconductor device in the first stages – it may be obsolete!

... W4KAE ■



RF APPLICATIONS OF THE DUAL-GATE MOSFET

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Mountain View CA

Metal-oxide-semiconductor field-effect transistors (MOSFETs) that feature two independent insulated gates represent a new class of semiconductor device, extending the analogy between transistors and vacuum tubes beyond the triode. In effect, these devices, called dual-gate MOSFETs, are the solid-state analog of the dual-grid vacuum tube (tetrode).

Dual-gate MOSFETs have all the characteristic features of single-gate MOSFETs (high input impedance, low noise, and wide dynamic range) but, in addition, provide better agc and cross-modulation characteristics and significantly lower feedback capacitance. While addition of a second gate increases manufacturing costs slightly, the small price increase is more than offset

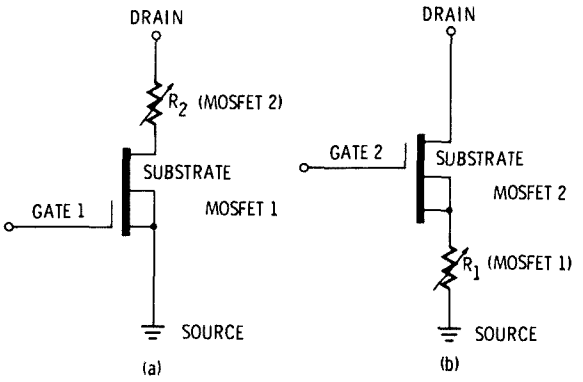


Fig. 1. Two equivalent MOSFET circuits to show signal injection at (a) gate 1 and (b) gate 2.

by eliminating the need for some components normally required in conventional MOSFET circuits.

The special characteristics of dual-gate MOSFETs make these devices ideal as UHF, VHF, and FM amplifiers, VHF and FM mixers, and i-f amplifiers.

Circuit Performance

Dual-gate MOSFETs, like other FETs and bipolar transistors, are used for signal amplification. The signal can be injected at either of the two gates, but normally gate 1 is used for signal injection and gate 2 for gain control. This preference can be explained by analyzing the two alternative equivalent MOSFET circuits shown in Fig. 1. Figure 1a shows the equivalent circuit with signal applied to gate 1, and gate 2 ac-grounded. In this mode, when the dc bias of gate 2 is changed, MOSFET 2 acts as a variable-load resistor on MOSFET 1, representing a gain change.

By contrast, Fig. 1b shows the equivalent circuit with signal applied to gate 2, and gate 1 ac-grounded. In this mode, gate 1 is used for gain control and MOSFET 1 acts as a series source resistor. As the dc bias voltage on gate 1 is changed, the value of the source resistor will increase or decrease, and gain control is accomplished. However, this mode of operation results in lower gain because of the degenerative series resistor, and since gate 2 is closer to the drain, the feedback capacitance is higher compared with the other mode of operation.

When the device is operated as shown in Fig. 1a, the MOSFET is analogous to the common-cathode, common-grid cascode tube amplifier used for high degree of isolation between input and output stages.

Dual-gate MOSFETs have the following advantages over the triode MOSFETs.

- Low feedback (reverse-transfer) capacitance, which allows the device to operate as a very stable amplifier.
- Excellent agc performance with an agc range of approximately 50 dB. This characteristic makes the device ideal for use in front-end applications. The agc range of Fairchild's FT0601 is shown in Fig. 2.

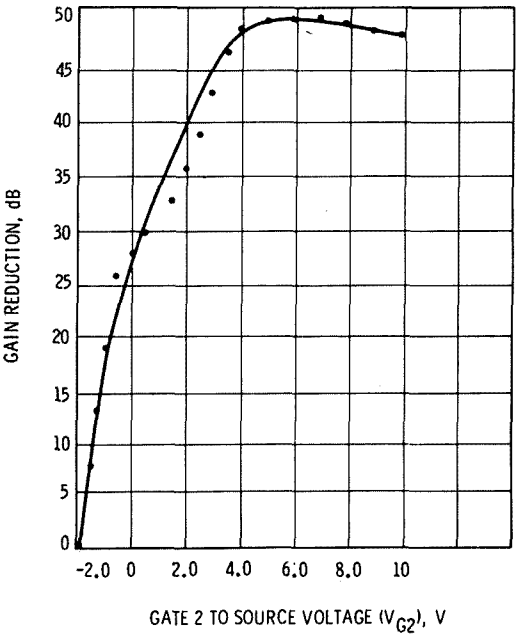


Fig. 2. Agc performance of the FT0601 (V_D = 15V, F = 200 MHz).

- Good cross-modulation performance. Dual-gate MOSFETs have square-law transfer characteristics; therefore, they are suitable for amplifiers that require minimum cross-modulation distortion.
- Uniform and fixed input and output conductances, which do not change greatly with the agc voltage. This can be seen in Fig. 3, which shows the

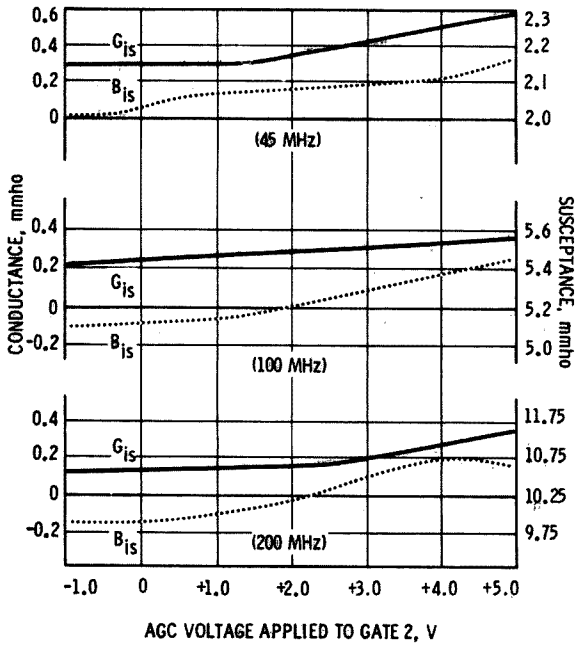


Fig. 3. Admittances of the FT0601 as a function of agc voltage.

input and output conductances and susceptances of the FT0601 as a function of the agc voltage. This characteristic of the FT0601 makes the device suitable for tuned amplifiers.

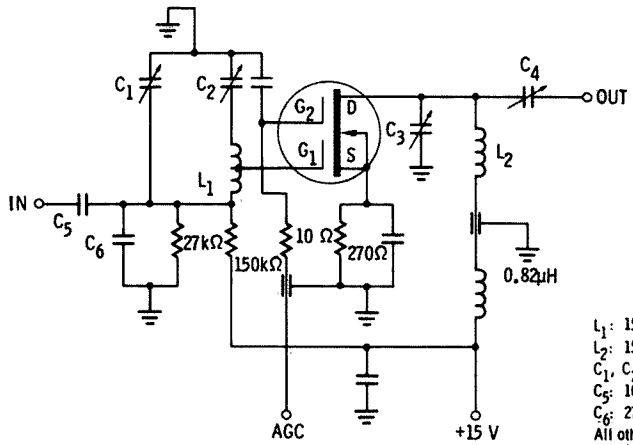
- Diode protection of both gates, which eliminates the possibility of device destruction due to buildup of static electricity.

RF Applications

Dual-gate MOSFETs offer two important advantages over bipolar devices in rf applications. First, agc operation is made easier because of the separate signal and agc gates. Secondly, their input admittance does not change with agc; consequently, the performance (center frequency) of MOSFET tuned amplifiers is unaffected. The chief rf applications of the FT0601, listed below, utilize these advantages.

VHF Amplifier. Good-quality receivers use automatic gain control at the front end to improve reception for a wide range of input signal levels. For agc operation, dual-gate MOSFETs have a built-in advantage owing to their separate gates, especially in the VHF region. VHF amplifiers built with the FT0601 eliminate cross-modulation distortion, decrease receiver noise, and avoid shifting of the receiver's center frequency. Figure 4 is a circuit schematic of a VHF amplifier using the FT0601.

VHF Mixer. The FT0601 has good gain throughout the VHF band and can be used as a front-end amplifier. However, the device has a nonlinear transfer function region and, therefore, it can also be used as a VHF mixer to provide conversion gain. The mixing action takes place in the least linear section of the VHF band, and the gain is obtained where the device is completely linear. Therefore, when a VHF mixer is designed, a compromise is needed between gain and mixing action, and, as a rule, gain is sacrificed. The conversion gain is defined as the ratio of i-f power output to rf power input.



L_1: 15/64" ID coil, 0.8" long, 5t of gauge 18 wire, silver plated, tapped at 2.5t
L_2: 15/64" ID coil, 0.8" long, 4t of gauge 22 wire, silver plated, tapped at 2.5t
C_1, C_2, C_3, C_4: 1-10pF, Erie VAM010
C_5: 100pF, dip mica
C_6: 27pF, dip mica
All other capacitors: 1000pF, FT

Fig. 4. VHF amplifier.

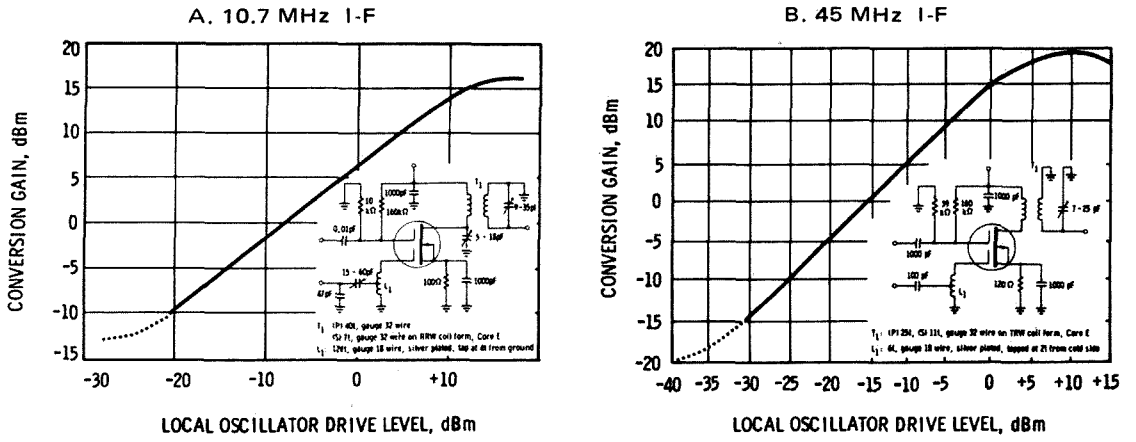
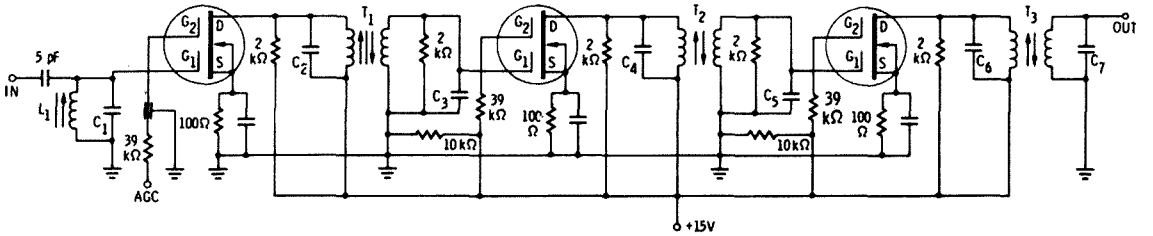


Fig. 5. Conversion gain vs local oscillator drive level for the FT0601.

The amplifier provides optimum rf power gain with the FT0601 when the drain current varies between 8 and 10 mA, while the mixing action takes place at drain currents of 3 to 4 mA. Our experiments indicated that best conversion gain is obtained when the device is biased at 5 to 6 mA of drain current.

local oscillator drive level, and the circuits used to measure the conversion gain are shown in Fig. 5 for 10.7 MHz and 45 MHz. We designed these circuits with emphasis on stability and high gain, thus the chosen bandwidths are not optimum: 1 MHz for the 10.7 MHz signal and about 2 MHz for the 45 MHz signal.



C_1, C_3, C_5, C_6, C_7: 10 pF, dip mica
C_2, C_4: 15 pF, mica
All other capacitors: 1000 pF
L_1: 6-1/2t, gauge 24 wire on 5/16" form, J-slug
T_1, T_2, T_3: 6-1/2t, gauge 24 wire, J-slug, 5/16" form, adjustable

Gain: 62 dB
BW: 4.5 MHz @ -3 db
AGC Range: -9 V max, +4V min AGC, 3 db tilt
I_t: 27 mA

Fig. 6. 45 MHz i-f strip using the FT0601.

When a dual-gate MOSFET is used as a VHF mixer, the local oscillator and rf signals can be applied to separate gates. We obtained the best conversion gain with the rf signal applied to gate 1 and the local oscillator signal to gate 2. We biased gate 1 to dc ground and applied the rf signal to this gate through a conjugately matched network; but did not conjugately match the network to the i-f impedance of the device to avoid the possibility of oscillation. The conversion gain as a function of

IF Strip

Dual-gate MOSFETs are suitable for i-f strips where the Q of the tuning circuit is critical. We built a 45 MHz strip using a FT0601s in all stages. However, to avoid instability, a large amount of mismatch was needed in all stages; therefore, we loaded the stages with 2 kΩ input and output admittances. The circuit schematic of the strip and the performance data are shown in Fig. 6.

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Peter A. Lovelock W6AJZ
235 Montana Avenue
Santa Monica CA 90403

Remote Quad Tuning

The cubical quad has become one of the most popular beam antennas for the DX'er. But something less than popular is the problem of tuning the parasitic wire reflector for optimum performance. Many weary miles of tower climbing, seasoned with ripe expletives, have been expended on this labor of love. Field strength meters, arm-waving assistants, neighboring hams, and even CB handsets have been pressed into service. . .after all of which there is lasting doubt that the beast is really adjusted right on the nose. How much happier if this onerous task could be accomplished in the relative comfort of the shack!

Well, pilgrim, your search is over. For tuning a quad can be relegated to the mere twist of a knob as you relax at the operating position.

Whether homebrew or commercial, the length of the quad reflector is commonly cut for one wavelength, identical to the driven element. Tuning is provided by inserting the appropriate amount of inductive reactance – dependent upon spacing from the driven element – to produce the necessary phase shift in the reflector for maximum forward gain or front-to-back ratio.

Figure 1 illustrates three popular methods for adjusting inductive reactance at the reflector. Figure 1A uses an adjustable shorted stub which exhibits an inductive reactance at its open end, the value of which depends upon the position of the shorting bar; 1B incorporates an open stub, the length of which is made greater than ¼ wavelength, so that it similarly exhibits an inductive reactance which can be varied by the capacitor. Figure 1C uses a suitable coil with an adjustable tap, and is the method included with a number of commercially manufactured quads.

As old hands will know, the actual adjustment is quite critical for maximum performance. For example, I have found that with the method of Fig. 1A, plus or minus ¼ in. in positioning the shorting bar

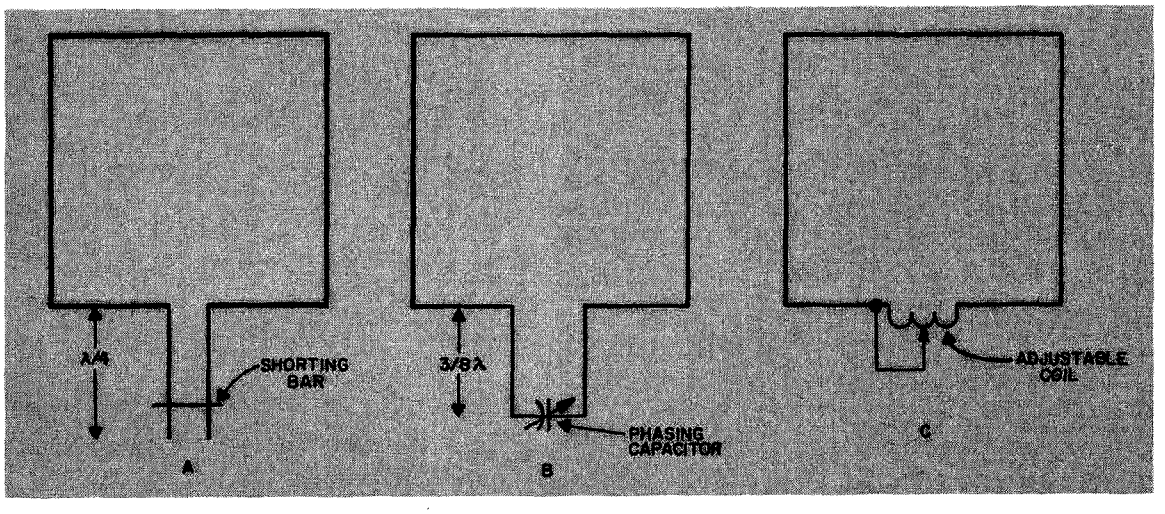


Fig. 1. Basic methods of tuning quad reflectors.

makes the difference between a directional quad and bidirectional stacked dipoles.

The remote method of tuning my quad reflector is an adaptation of Fig. 1B. Since an open-ended stub greater than ¼ wavelength is inductive at its terminals, it follows that extending the length of the stub by any multiple of half wavelengths will produce the same inductive value at the terminals. Connecting a variable capacitor across one end of this extended stub will enable the value of inductive reactance at the other end to be varied.

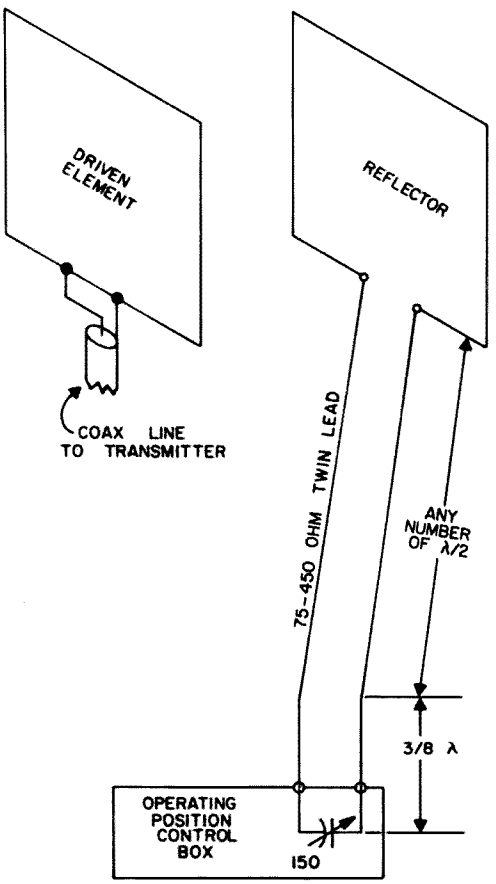


Fig. 2. Arrangement for remote tuned stub.

In plain words, you cut a length of transmission line to the number of half-waves needed to reach from the quad reflector to your operating position, plus an additional 3/8 wavelength. The adjusting capacitor at the operating end may be about 150 pF (variable receiving type). Figure 2 illustrates the setup.

Transmission line used for the elongated stub would ideally be on the open wire, 300–450Ω type. However, if this is physically impractical, 300Ω TV line will work almost as well, though moisture on the line may result in reactance variations out of the adjusting capacitor's range. The best solution was found to be the tubular, foam-filled, low-loss 300Ω TV line, which exhibited minimum variations when exposed to rain or snow.

In calculating overall stub length, the velocity factor of the actual line used must be applied. Taking the basic stub length to the 3/8 wavelength, the formula will be

$$\frac{351}{f(MHz)} \times V \times M$$

where f = resonant frequency of the driven element and V = velocity factor of the type of line used for the stub. Added to the basic stub length must be a length of line suitable to run from antenna to operating position, for which the formula is

$$\frac{468}{f(MHz)} \times V$$

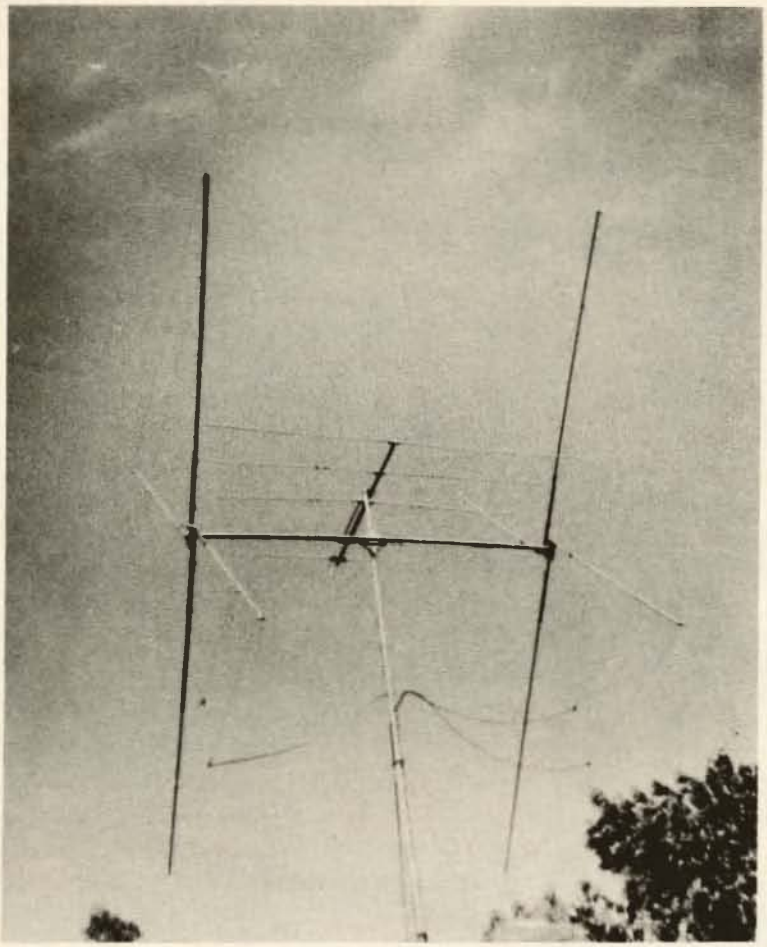
where m = the multiplier to achieve the length required.

For example, using 300Ω TV line with a velocity factor of 0.82 for a resonant frequency of 28.5 MHz, the basic stub length would be 351/28.5 x 0.82 = 10.0 ft. Supposing antenna-to-shack distance is a 50 ft run – an additional length calculated as 468/28.5 x 0.82 x 3 = 40.2 ft. The length of the basic stub, plus the half-wave multiple extension will then total 50.2 ft.

Velocity factors for readily available balanced lines suitable for constructing the elongated stub are as follows:

a) Open wire (any impedance) V = 0.975
b) Flat TV line (300Ω) V = 0.82
c) Tubular TV line (300Ω) V = 0.82
d) Flat TV "twin lead" (75Ω) V = 0.68

Once you have the elongated stub cut to the required length, and connected to the open terminals of the reflector, connect the variable capacitor to the operating end and turn the quad back on to a ground-wave signal; another local ham or a signal generator with short antenna positioned a few wavelengths away. Vary the capacitor and watch the receiver S-meter for a null



10 and 15 meter quad with remote tuning stubs.

on the signal. If none is noted it will be necessary to carefully prune the stub to bring the inductive value into the range of the capacitor. Cut off no more than 2 in. at a time, reconnect the capacitor and try again. Repeat this process until varying the capacitor produces the desired null. Finally prune the stub just enough to bring the null to the mid-value of the capacitor.

It is assumed that the driven element has been resonated and matched to the transmission line before adjusting the reflector stub. Once the stub has been pruned, and power is applied to the antenna through an swr bridge, a distinct variation in swr will be noted as the stub capacitor passes through the null position, and if the driven element is properly matched minimum swr will occur at reflector-optimum setting of the capacitor.

When the quad is facing a ground-wave station it is possible to adjust the stub capacitor for maximum signal, and the setting will be slightly different from that for front-to-back ratio. The capacitor will also compensate for wet weather conditions and permit optimum tuning of the reflector when moving around the band.

For a multiband quad, a separate elongated stub will be required for each reflector. The photo shows my 10 and 15 meter quad (don't be confused by the TV antenna mounted between the elements), with the common transmission line at the left and the two stub lines to the right. While this method has been described for a two element quad, there is no reason why it can't be applied to 3 and 4 element quads, if you care to run the extra lines, or to any parasitic type array for that matter.

With the tuning capacitors mounted in a small box at the operating position, assurance that your quad is giving maximum performance is as simple as just tweaking a knob.

. . . W6AJZ ■

2 Watt 6 Meter Transmitter using the Heterodyne VFO

Bill Hoisington K1CLL
Far Over Farm
Peterborough NH 03458

This article describes the breadboard design, tuneup, and results of an rf power stage on 6 meters using the $2.95 Motorola 3-watt HEP-75 transistor (similar to the famous 2N3866). This rf stage is designed to work from an input power of 120 mW such as furnished by the 6 meter crystal-heterodyne-vfo circuit described in a previous issue of 73 Magazine. Two types of inputs are detailed, one using a single capacitor, and the other a matching network for use with any length of cable. At a dc input power of 2W using a 12V battery, a good clean watt of rf output power is obtained.

Circuit and Design Theory

Figure 1 shows the schematic, using the input matching network. The design of a VHF input circuit can take various forms, depending on whom you read, what you read, and the proposed use of the rig. In

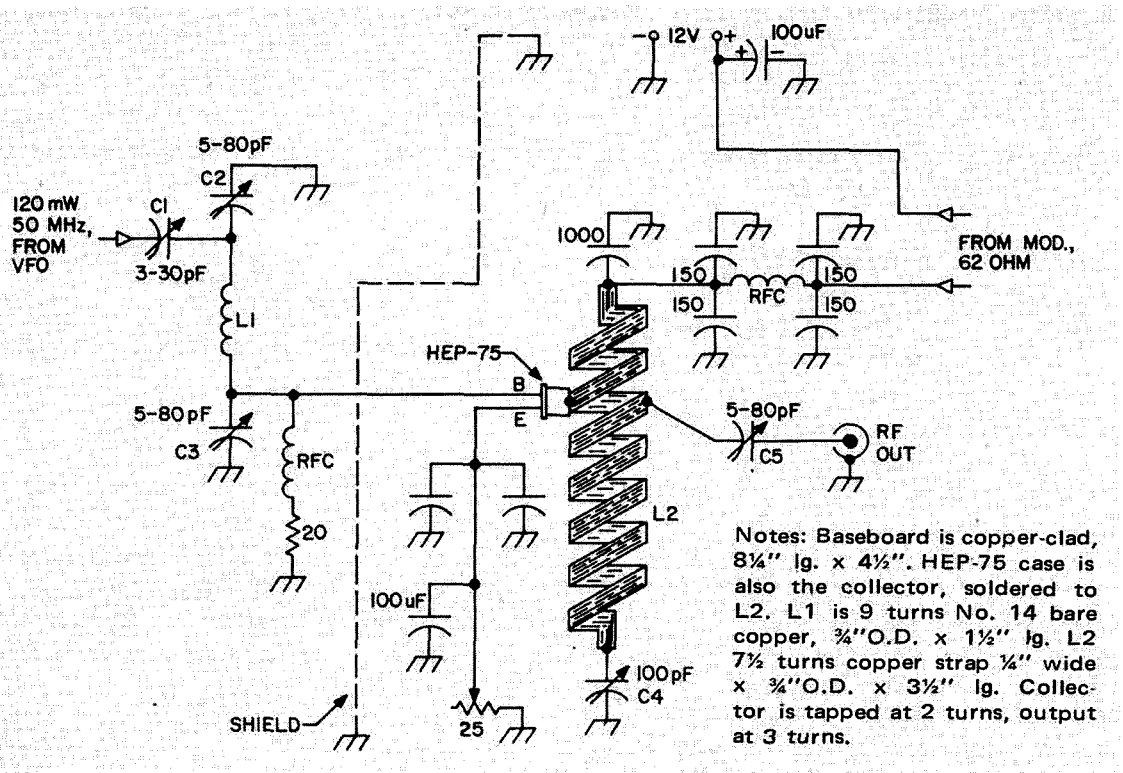


Fig. 1. 2 watt, crystal-heterodyne-VFO 6 meter rig.

this case, we want sure-fire operation, an easy-to-build circuit, freedom from self-oscillation, smooth tuning, 12V operation, and "carrying" type portability for hill-topping emergency use, and mobile work, as well for use at home.

The circuit in Fig. 2 uses a capacitor from J1 to the base. It works, and should be sufficient in the case of an excess of input power (not too likely), and where you don't mind adjusting cable length. However, if you're building up from only 120 mW of vfo output, you may want maximum power transfer along with the ability to match various cable lengths, and direct inputs (as in the case of packaging the entire rig in a box).

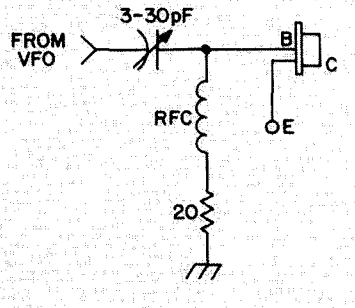


Fig. 2. Simplified input circuit, 2 watt, 6 meters. (Temporary)

The circuit of Fig. 2 is reliable and good for a "quickie" any time. But it does not always furnish maximum drive or best input match unless the cable length and output tap on the vfo output inductor are adjusted. These latter are of course indications of mismatch, but for short lengths of cable there is little loss, so you can operate that way if needed.

DC Base Lockup

This nasty little trouble has not been mentioned in the rather large amount of literature persued here through recent years. I can just hear some know-it-all lads saying, "Ho, Ho, he's just discovered the Poniatowsky effect." Well, maybe so, but whatever its name is, it arrived here and I don't like it! Here's what happens: With an rf choke from the base to ground and *no* resistor, and an rf input driving the collector to about 200 mA, cutting off the rf

excitation does not cut off the collector current. There is no rf involved and it seems to be a dc type of hangup. Just for fun I'll wait until someone tells me its name. In the meantime, back on the breadboard, the cure was easy. Just include a little resistance in the base circuit. That's why the 20Ω job is there.

Input Matching and Base Circuit

After trying out various combinations of circuits as shown by RCA, Motorola, Fairchild, and others, the circuit of Fig. 1 was judged best. Inductor L1 can also be an air-wound coil 5/8 of an inch O.D., 8 turns per inch, with 5½ turns (not too critical).

Just a word of caution here about overloading receiver inputs while testing transmitters. While checking with the lab receiver, with its antenna only 10 in. away from the 1W rf output of the amplifier, the receiver was completely blocked out and detuned by the rf. The addition of only 1 in. of wire as a test antenna brought things back to normal. A very peculiar effect; expect almost anything when you start to run power. In solid-state VHF, "power" refers to anything over 1W.

Emitter Circuit

No trouble here. Two capacitors were used for bypassing, which are not really 100% in parallel. That is, with the ground leads of the capacitors going to slightly different ground points and the two leads cutting down the lead inductance by a large factor, the emitter is pretty well tied down to the ground plane rf-wise. A 25Ω pot controls power output from about 0.25 to 1.0W with 120 mW of rf input power and 2W of dc power.

Due to the base resistor requirements, no limiting resistor was needed in series with the 25Ω emitter pot which operates nicely as an rf power control (although 2W dc input does not particularly strain the HEP-75). A 100 μF capacitor was later shunted from the emitter to ground for better modulation properties.

Collector Circuit

Several requirements must be met here, some of them not usually compatible, but things worked out quite well as you will see in the results section. A good high-Q inductor is desirable for maximum selectivity when loaded by the antenna, and at the same time good heatsinking is needed. Fortunately, there is a design that will accomplish both of these requirements at the same time. The secret; Plenty of copper. Thus the edgewise-wound copper-strap inductor shown in Fig. 1. The collector is internally connected to the case, and to keep the inductance low and the heat conductance high, the case can be soldered directly to the copper strap. Do not use a large iron, and be sure to tin both the strap and the transistor case first. Use the minimum amount of time and heat to do this, consistent with a good solder joint.

Note that the collector is tapped pretty far down on the inductor (near the cold end); this is done for impedance matching purposes. With direct currents of nearly 200 mA at 12V, you can see that the rf impedance will be low. This gets to be a big problem when you get up into the hundreds of watts, but at 2W matching can be done by tapping the collector on the second turn of a 7½-turn coil as shown.

The copper strap also takes care of the heatsink problem by conducting the heat away from the collector in both directions along the strap. With more powerful transistors, use is made of a beryllium oxide or aluminum oxide insulating stud, which conducts heat quite well but *not* electricity. So far they cost a lot more, but we can always hope they will come down in price.

Collector Dip Notes

With the HEP-75 collector circuit detuned, the current is near 200 mA; with it tuned and unloaded, the current drops to about 50 mA just like in the good old days with tubes. Believe it or not, a spark can be seen when applying the pencil test to the high rf end in the unloaded condition. I generally load the circuit with the antenna so that a slight dip of, say, 10% is obtained. With an rf power indicator in the antenna line a precise adjustment can be made.

The RF Output Match

While not critical, the output connection does require care and testing to obtain

a good match and maximum power output at 50 MHz.

Tapped onto L2 and 2½ turns (Fig. 3) is a 5–80 pF Arco compression trimmer (Model 462), which does a good job of matching a 0.9 or 3W bulb to the collector.

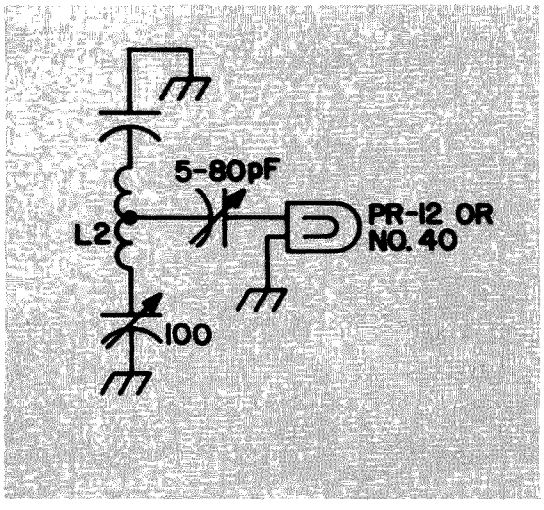


Fig. 3. Output test circuit.

With the input circuit of LI tuned correctly and 180 mA showing in the collector circuit while detuned, and rocking C4 slowly through the dip at resonance, the proper adjustment of output coupling capacitor C5 can be obtained.

The adjustment for a pilot light match is not necessarily the same as for a 50Ω cable. Leading to coax requires readjustment of output capacitor C5 and possibly the tap on L2.

I found 160 mA to be about the maximum output. If you load L2 down to where there is less dip, your power and selectivity against harmonics will suffer. It is best to use a shade less coupling, sacrifice a small percentage of your power, and obtain good discrimination against harmonics. (Don't forget that second harmonic of 50 MHz right in the middle of the FM band!)

Homebrew Wattmeter

This is something I'll really have to look deeper into, because there are rf wattmeters on the market, but they start at $49.50 for 2–30 MHz and go up in price along with the frequency. With all the material that the young builder has to purchase, perhaps on an "allowance" budget, he just has to pass up such luxuries.

In the meantime, back at the old bench, turn to page 259 of Lafayette's 1970 catalog and you will find a list of pilot lights with a wide variety of wattage. You can push these along at a lively dc clip to perhaps twice the rated voltage. After all, most of them sell for only 15¢ to 90¢. The only thing is that after you get up to a watt and over it begins to be a little tough on the eyes! So use a higher rated lamp than actual rf power. In the Lafayette list you will see the number 48 and 49 for 120 mA (good for oscillators), the 40 and 47 at 1W, the PR13 for 2.34W along with the PR12 for 3W, and the 432 and 433 for 4.5W, etc. A lot depends on what you can find in your local hardware store if you're in a hurry right now to know how many watts output you have. There comes to mind the question of whether or not the pilot lamps light to the same brilliancy on rf wattage as they do on dc. All I can say is that when a lamp is lit by rf to the same brilliance, there must be *at least* that much wattage. If the final is tuning nicely at the proper loading point, as mentioned above for maximum power out, it is reasonable to suppose that most of that rf is going into the filament of that pilot lamp, and will show up as heat.

To make a real handy wattmeter for pennies, set up a little panel or minibox with lamp, battery, pot, and dial knob calibrated in watts. To calibrate, simply read the amps times volts for different positions, using the method of successive approximations to get round numbers for easy reading on the dial.

To solder a connection onto the aluminum base of a bulb, use a good clean tinned iron, scrape the aluminum clear of any oxide, and use a rubbing motion of the iron to tin the aluminum for about 3 or 4 seconds. Friction, plus heat and solder flux, helps solder to adhere adequately to aluminum.

For use with the transmitter, just position the wattmeter bulb alongside the one lit by the rf and adjust for the same

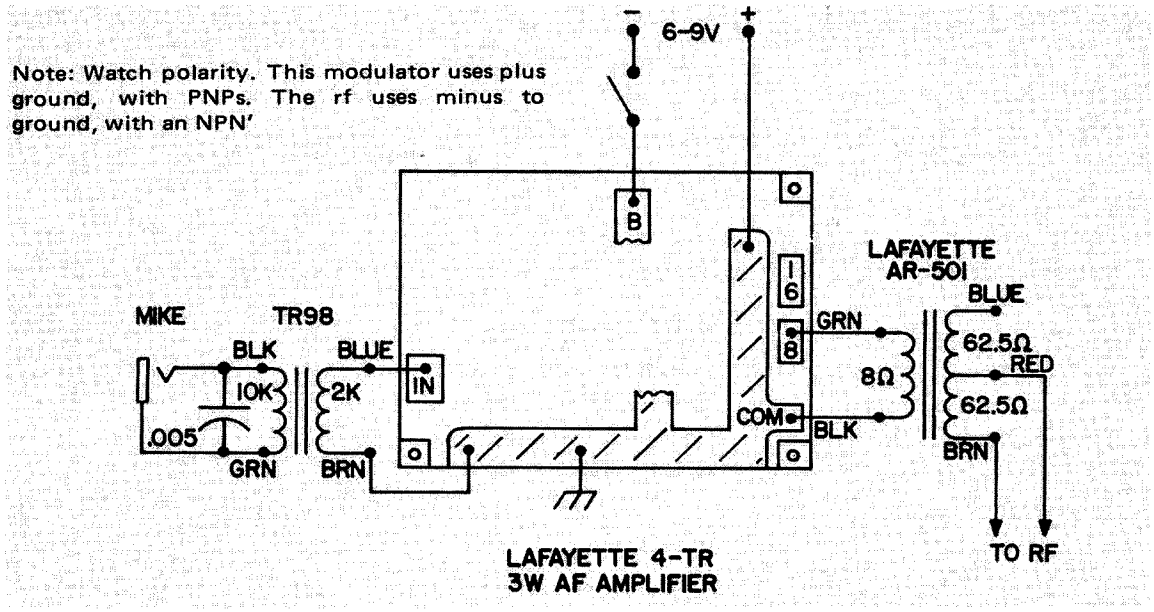


Fig. 4. Modulator circuit, 2 watt, 6 meter rig.

brilliance. The human eye is supposed to be quite good at this type of comparison. It works.

The Modulator

There is a ready-made unit for the modulator, which only costs $7.95 and has 3W of audio output. This is the Lafayette "4-TR," 99E91432. It is a chunky little package, uses an RC-coupled input stage, a transformer coupled driver, and two power transistors in push-pull, with an output transformer having 8 and 16Ω outputs.

The unit fully modulates the 2W rig. At this particular time I have yet to decide between the transformerless output circuits and those using a transformer. It may well be that certain systems need transformers, and others, such as hi-fi sets, are better without them. As some engineers have pointed out (mainly those engineers from telephone companies!), the best of FM broadcasts reach you through a minimum of ten or a dozen transformers, so why worry about one more?

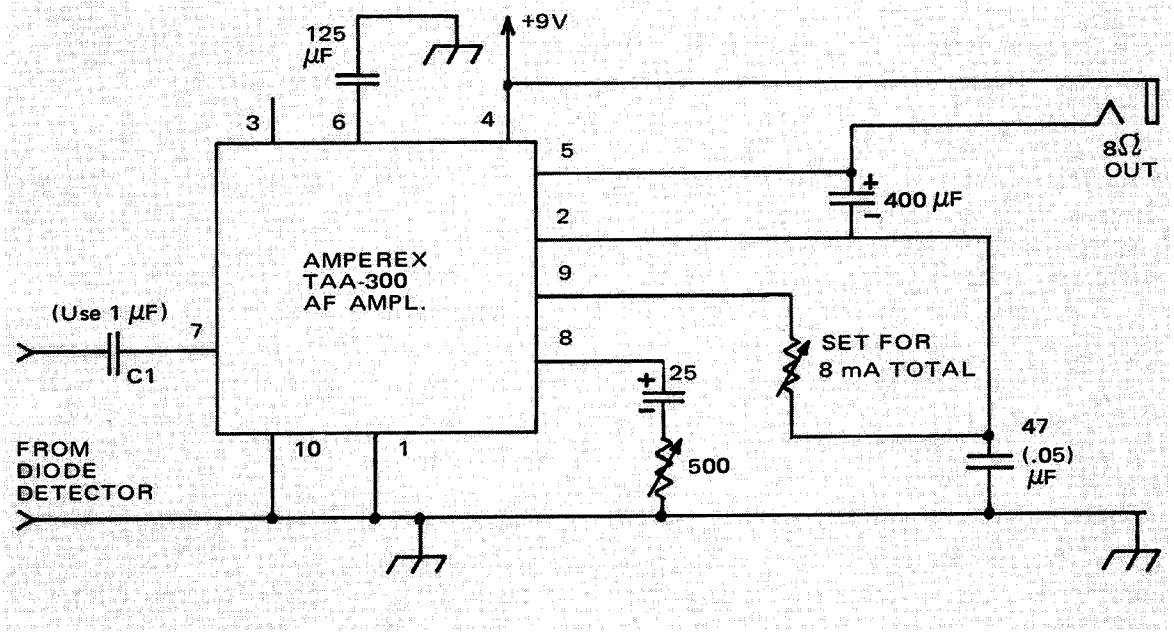


Fig. 5. Modulation monitor, 2 watt, 6 meter transmitter.

So, for a modulation transformer, not having found the ideal as yet, we use another, back to back with the 4-TR winding of 8Ω, The nearest to 75Ω I could find was the Lafayette AR-501, which has an 8Ω winding on one side and a 125Ω winding on the other (centertapped). It worked out fine on the air, in the circuit shown in Fig. 4. As the power goes up on this type of rig, with one or more HEP-75s, possibly to 10W or so, the modulation impedance will drop below the 48Ω region. In this area there is the 10W "universal" transformer with taps at 4, 8, and 16 on one side and 8, 12, 16, 24, and 48 on the other side, at only $3.95. A major benefit of low-impedance solid-state devices now becomes evident, as you don't have to pay for much copper.

In my transmitter, only the final is being modulated. Tests were carried out using only a 6V battery on the modulator because the only 9V batteries I had on hand were those little jobs for Jap radios – and they will *not* furnish 500 mA!

Excellent modulation reports were obtained on the air, however.

A good idea for checking your own modulation on a dummy load before you put it on the air is to use an Amperex TAA-300 integrated circuit, as shown in Fig. 5. This little gem is actually a miniature hi-fi set all by itself, and it really tells you what your own rig – with *your own voice* modulating it – sounds like to others on the band. To do this you need also a set of earphones, with good padding to keep your voice from reaching your ears through the air. The Lafayette Model 8X stereo headphones ($7.95) are excellent for this, with 8Ω impedance per phone. Just connect the two phones in parallel in a three-circuit jack.

Connect a tuned diode receiver in front of the TAA-300 to pick up the rf from the transmitter, and use the Amperex external circuit as shown in Fig. 5.

The TAA-300 is an excellent example of a modern audio-type IC using eleven transistors and five diodes, with a frequency response of 20 Hz to 25 kHz. Naturally, you don't need all that range for voice communications work so the following modifications were used to cut down the highs and reduce the lows. Replace C1, 0.6 μF, with a 0.01, and install a 0.005 across the input jack. Regular treble and bass tone controls can be made up but they should be put in a minibox to minimize hum because there is a lot of gain at 60 Hz in the little tin can. I also put a pot in place of the 48Ω feedback shunt resistor, because making the negative feedback control variable has very interesting possibilities, as you will see when you operate it. The TAA-300 also makes an ideal amplifier for any amateur receiver using transistors.

On The Air

Not waiting to hook up an rf power monitor, I connected the 50Ω cable from my 4-element beam through a ceramic rotary switch for use as in Fig. 6, to change

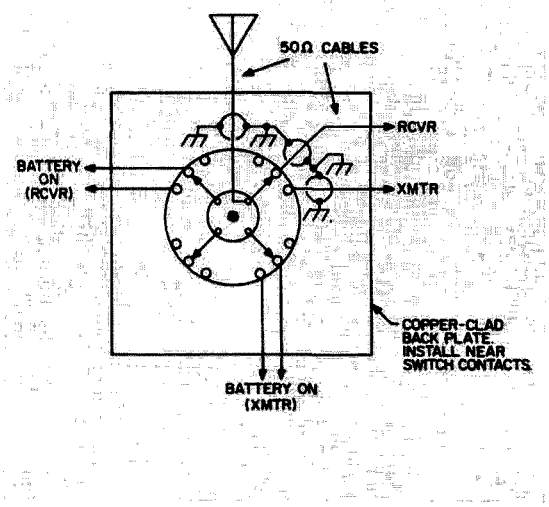


Fig. 6. Send-receive switch, 6 meter, 2 watt transmitter.

over the antenna and turn the receiver and transmitter on and off, and tuned for the same dip in the collector current that had shown maximum power into a PR-12 3W pilot lamp. This did the job. In October 1969, I tuned the vfo to a good loud signal on the band and he came right back to me. This was W1ZLG, a Massachusetts station 55 miles away. His report: "Modulation very very good."

...K1CLL ■

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SEMIAUTOMATIC FM CHANNEL SCANNING

The completion of the second 2 meter FM repeater in Wichita left me with the problem of trying to monitor both repeater frequencies simultaneously, on a one-receiver budget. Manually flipping the channel selector was a tiring method which set me to work on a way to electrically perform this same function with the least expense and design effort. The solution was a circuit made up of a "flasher" module, two transistors, and five resistors.

I call this a "semiautomatic" scanner because the unit will not "lock on" when a signal appears on a vacant channel. It

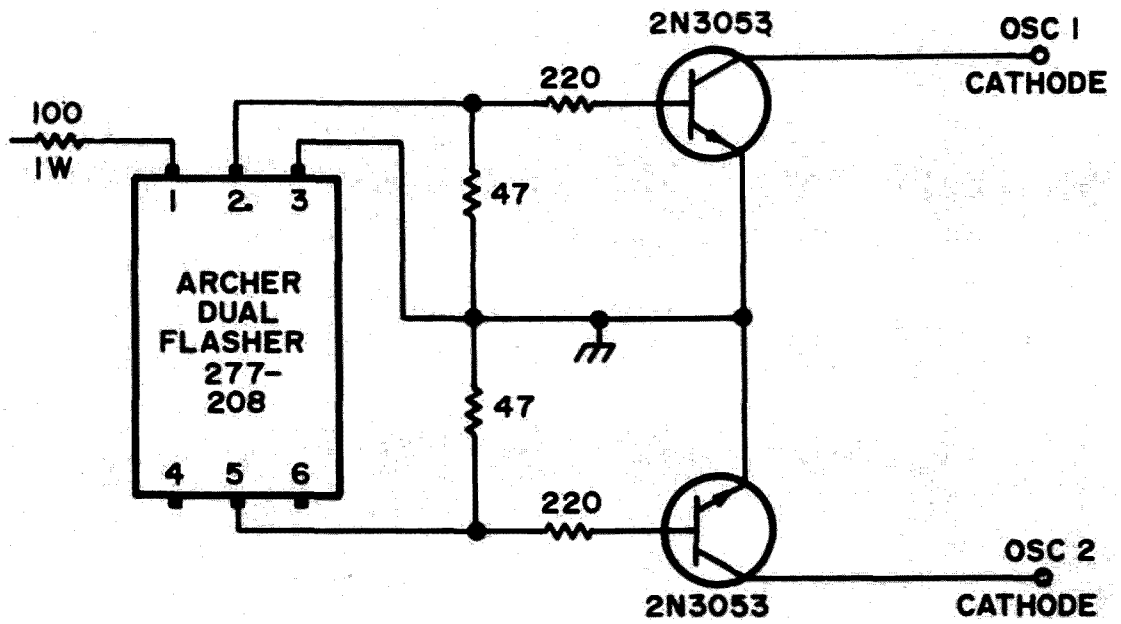


Fig. 1. A nonlocking scanner can be made easily by using an Archer dual flasher in conjunction with an external switching circuit.

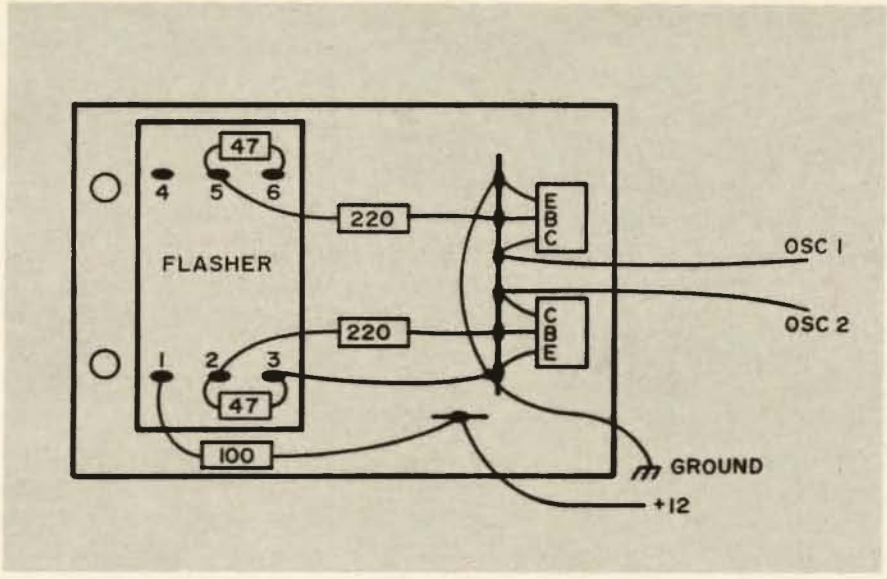


Fig. 2. Parts arrangement for mounting in GE Progress Line unit. When the scanner is in operation, all other cathode grounding circuits must be out of the circuit.

simply scans by monitoring first the F1 channel, then F2. When the operator wants to halt the scanning action, he merely turns off the unit by placing the frequency selector switch on the rig to the appropriate channel.

My mobile rig is a GE Progress Line, which switches receive frequencies by dc grounding the cathode of the desired oscillator. The idea was to use transistors to switch the oscillators, then make one of the low-priced experimenter flasher modules turn the two transistors alternately on and off. The module selected was the Radio Shack *Archer* dual flasher (277-208). The *Archer* unit is a 6V transistor multivibrator which cost $2.50. It can be easily duplicated, but the low-priced

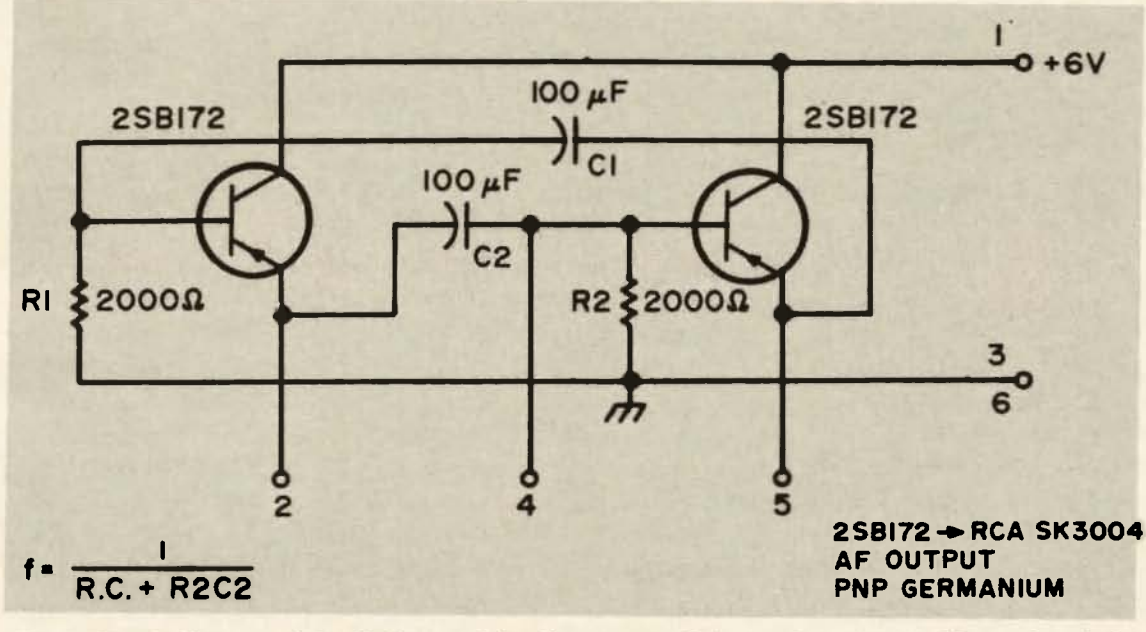


Fig. 3. Circuit diagram of the flasher module. Changing the RC values here (text) will permit variation of the switching frequency.

module is in an attractive case and includes a mounting socket.

For cathode switching, I used 2N3053 transistors because they were on hand; they are also very inexpensive if purchased new. If you make any substitution, choose a transistor that has a high collector–emitter voltage rating to withstand the potential difference between the floating cathode and ground.

In the circuit (Fig. 1) the 100Ω resistor is used to drop the 12V battery voltage to the level required by the module. The 47Ω half-watts are the load resistors, and the 220Ω resistors are used to supply a proper keying voltage to the transistor.

The "channel scanner" can be mounted up front with the control head or in the trunk with the receiver, as mine is (Fig. 2). When the unit is in operation, all other channel grounding must be lifted. On my rig I have a three-position switch which selects .94, .82, or, in the third position, leaves the cathodes floating and applies voltage to the scanner. The scanner can be permanently wired into the receiver. The switching transistors, with no voltage applied, offer a very high resistance which does not affect normal operation. If you have to rewire your receiver for remote switching, be sure to provide an rf ground at the tube cathode. GE uses a .02 μF capacitor.

The *Archer* flasher module is designed to operate at a frequency of 2.5 Hz. In this way, each channel is sampled about twice a second. The frequency can be changed by prying open the flasher module and changing the RC values. The circuit works according to this formula: I found that a frequency of 0.25 Hz was best for me (R1 and R2 20K, C1 and C2 unchanged). At this rate each channel is sampled for two seconds. You can also "lopside" the rate. I sample 146.94 for two seconds and 146.82 for 0.2 second (R1 = 2K, R2 = 20K, C1 and C2 unchanged).

I have been using the scanner for three months with no problems. The unit may not be as convenient as two receivers, but for the price, the "channel scanner" is a good way to always know what is going on, and where.

... WAØQPM ■

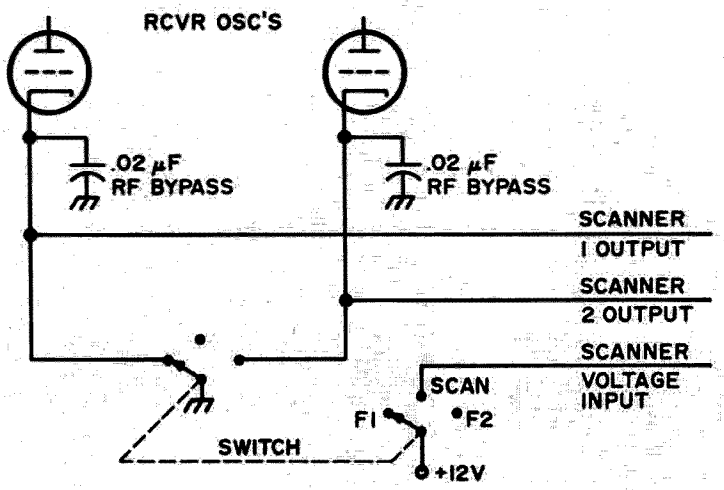


Fig. 4. This wiring diagram shows how the frequency selection is controlled. In the F1 and F2 positions, the appropriate cathode is grounded directly. In the scan position, the cathode ground is lifted and +12V is applied to the scanner.

Walt Pinner WB4MYL
7304 Lorenzo Lane
Louisville KY 40228

LOW COST AUTOMATIC KEYER: A "FIRST PROJECT"

If you don't build, START... if you do, try this one tonight

Here are details for constructing a 3 x 5 in. solid-state automatic keyer containing as few as two dozen components and five transistors. The speed range is from 10 wpm to far too fast for me. Over the past two years several versions of this keyer have been built and I have found the circuit to be very tolerant of transistor substitution (get 'em out of the junkbox, computer boards, or old transistor radios). The current drain is low (8–15 mA) and the unit performs well for a minimum-cost project.

Application

If you already own a transceiver with a built-in sidetone oscillator and have 12V ac available, you need only build the basic circuit Fig. 1, omitting the area in dotted lines. The circuit may be tucked inside your transceiver or mounted in a standard 3 x 5 in. minibox. If installed internally any convenient front panel control may be changed to one having the additional 100 kΩ speed control section needed without the necessity of hole drilling. A clear plastic disk may be installed behind the existing knob for speed adjustment, thereby maintaining the original appearance of the rig. On units with the earphone jack on the front panel, you may consider moving this jack to the rear apron and installing the speed control in this location.

Construction

Virtually all the components are point-to-point wired; therefore, if you enjoy making circuit board projects, a full-size layout is included in Fig.2. Figure 3 is a large component placement diagram. Several manufacturers produce copper foil tape, and a board may be made without etching by merely attaching pieces of this foil tape to heavy acetate or other base material. When using this method, it is imperative that a low-wattage soldering

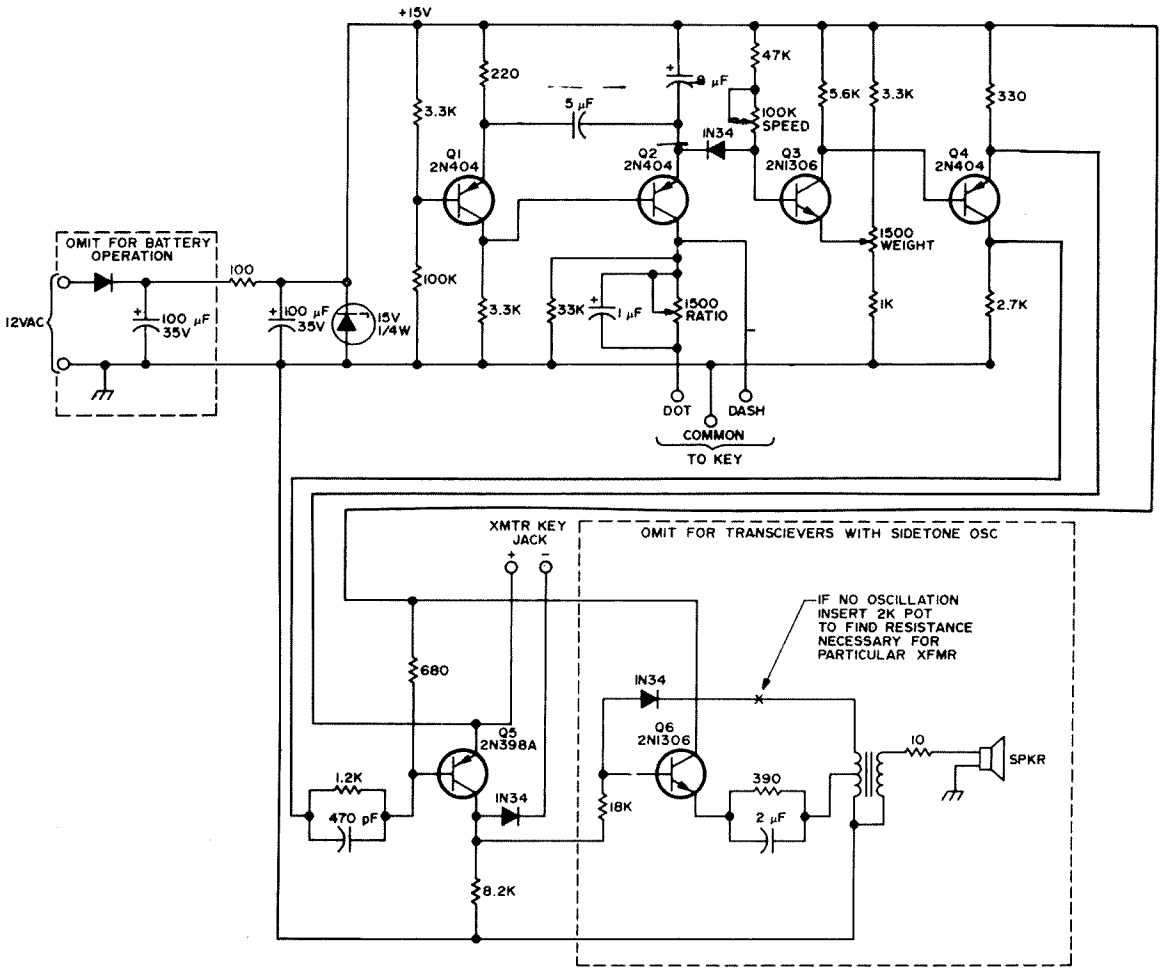


Fig. 1. Schematic diagram for the keyer. Note the marked-off areas at the left and right of the basic circuit. The enclosed area at the left is a rectifier so the power can be drawn from an existing 12V source. The sidetone oscillator is shown at right.

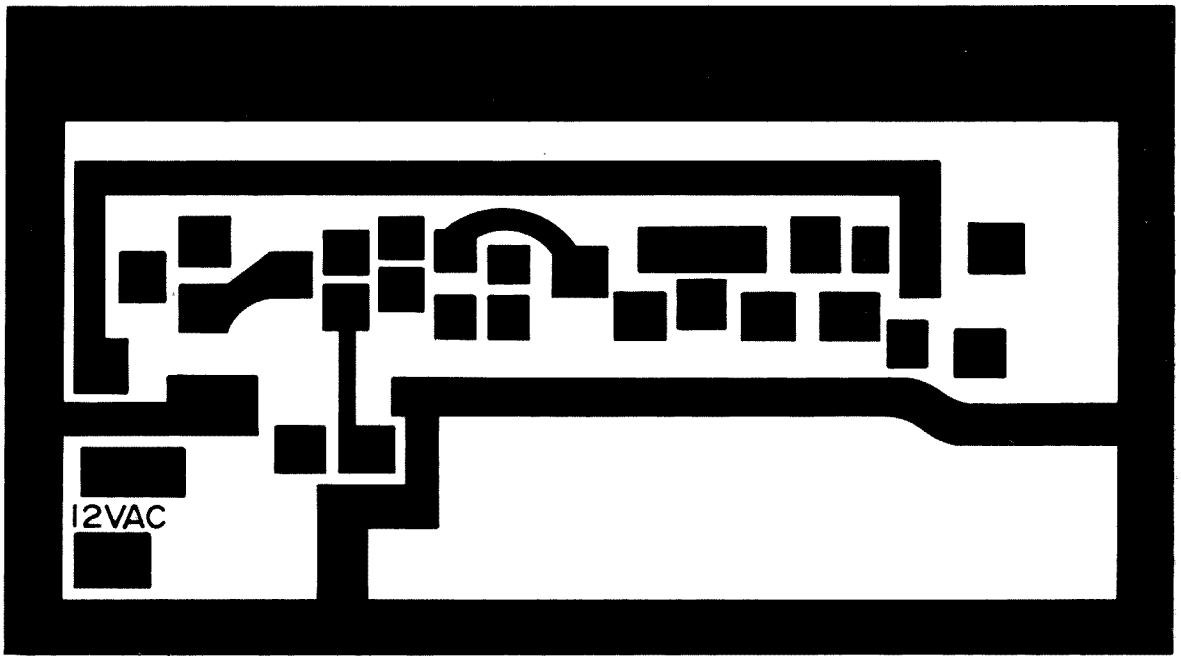


Fig. 2. This drawing may be used as-is to photographically produce an etched circuit board for the keyer assembly.

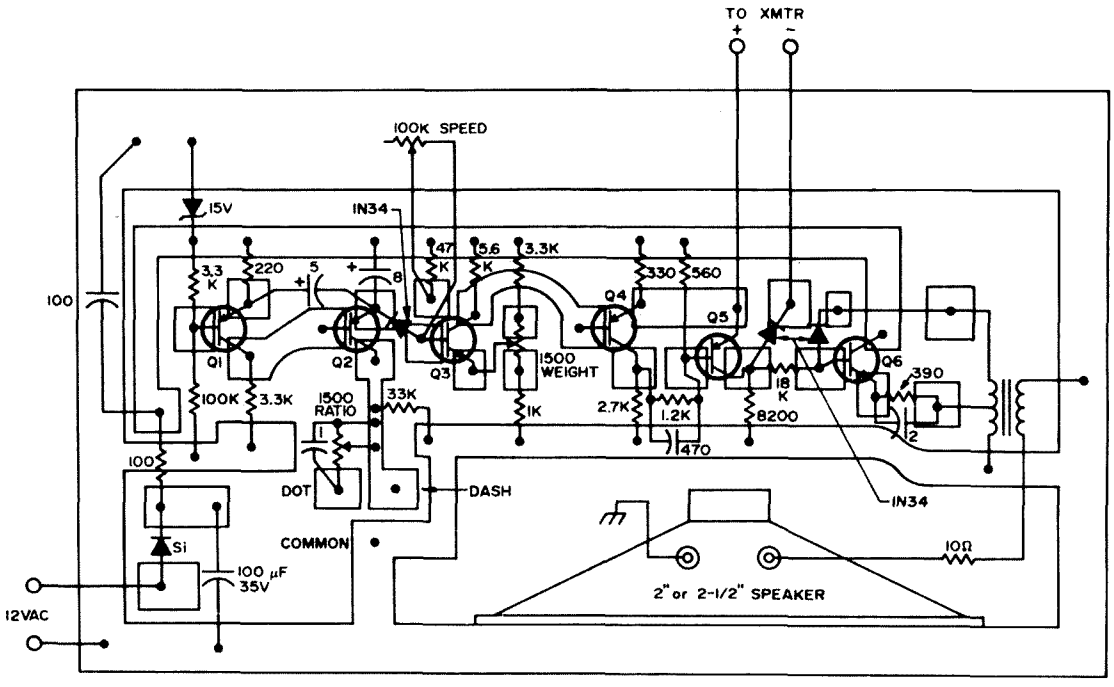


Fig. 3. This composite sketch should help in positioning of parts on the etched board.

iron be used to protect both the tape and the semiconductors during assembly.

A third approach is to use Vector board or Plexiglas and drill holes using the layout in Fig. 1, which will accept the Teflon base pin standoffs which are so common in many types of surplus gear and computer boards. Using this method, only three or four jumpers are required for the entire project. Should you elect to use the printed board or tape, solder all components to the foil side of the board. This will allow you to drop the completed board inside the minibox or secure it inside your rig without the need for electrical spacers or other insulation. This approach also saves you about 50 holes which you may need for a later project.

The speaker and transformer came from an old transistor radio. The last keyer I built used a driver transformer in the output, and even with the terrible impedance mismatch there was ample volume. Transistor Q6 can be almost any NPN audio transistor. Transistors Q1, Q2, and Q4 are very common on surplus boards or are available from Poly-Paks for about a dime apiece. Transistor Q3 is not critical and most NPN types work well. The transistor used for Q5 must have a V_{ce} rating in excess of the voltage at the transmitter during key-up periods. A 2N398A has a V_{ce} and V_{bc} rating of 105V, which is adequate for most transmitters. I found this transistor in a surplus pilot lamp assembly (24¢). The 1N34, zeners, and power supply diodes are all off computer boards, and with the exception of the zener, which should be 14–18V, other diodes may be substituted.

Circuit Description

This circuit, though relatively simple, produces dots and dashes which are self-completing. An audio oscillator provides ample volume for group work (if incorporated). This unit was designed for transmitters which are grid-block keyed. Cathode keying may be accomplished by replacing the 8.2 kΩ Q5 collector resistor with a reed relay or other sensitive relay.

Transistors Q1 and Q2 produce a sawtooth pulse for timing. The particular transistors used as well as the applied voltage will affect the speed range. If you

desire to alter this range, increase the value of the 5 and 8 μF capacitors for slower speeds and decrease these values for faster speeds. Transistor Q3 acts as an amplifier, while Q4 and Q5 form a trigger circuit to key both the transmitter and the audio oscillator.

Power Source

A simple but effective power supply can be obtained by connecting a few components across the 6V filament line, as shown in Fig. 4. Since the current drain is

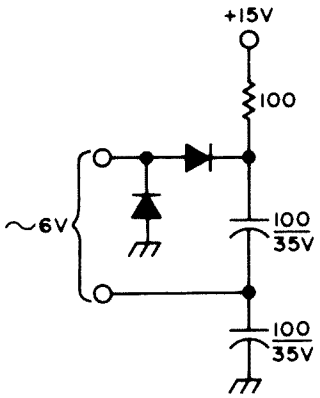


Fig. 4. A simple filtered voltage doubler circuit will convert the 6V ac filament line to 15V dc.

so small, though, a simple battery – connected between the 100Ω resistor and ground – will last a long time. You might even hunt around inside your rig for a 16V cathode resistor point and tap the necessary power there.

. . . WB4MYL ■

MANUFACTURERS

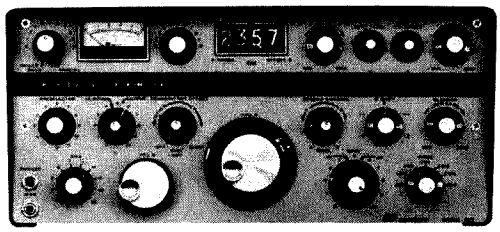
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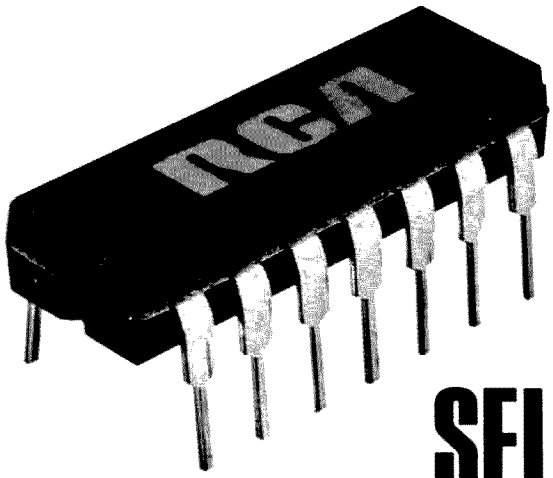
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AC SWITCHING WITH SELF-POWERED ICs

A new approach to power switching of ac circuits: RFI is eliminated, power supply diodes are protected, switch contact wear is reduced, and tube heater life is extended!

A cure-all to ac switching problems? Not so! But RCA's little CA3059 integrated circuit device goes a long way in eliminating many of the bugs we inherited with Tesla's genius. Formerly known as a monolithic silicon zero-voltage switch, it is now more handily identified by RCA's "CA" number. It is no bigger than a 2W resistor, yet it contains its own power supply and all the other functions shown in Fig. 1. When used with a half-dozen or so other common components, it does many wondrous things. Several are described in this article.

Basically, we would like to accomplish switching when there is no incoming voltage; that is, when the power line voltage crosses zero. This happens twice each cycle, or 120 times per second at 60 Hz. If we switch at this precise moment, no current is flowing through the switch; thus, radio-frequency interference is eliminated, as is contact wear. Incandescent devices, such as tube heaters and pilot lights, which have very low cold-resistance, are heated up "gradually" during a half-cycle if voltage is applied at one of the "zero" crossing times. They are, therefore, not subjected to a destructive high-current surge as before. In the same manner, we reduce the high surge current and minimize the peak inverse voltage imposed on our rectifiers when initially turning on a power supply. The zero-crossing detector in the CA3059 synchronizes the output pulses of its circuit with the time of zero-voltage in the ac cycle. Figure 2 shows this relationship.

But to be useful in switching normal loads, an external power device is needed. Thyristors such as SCRs (half-wave) or triacs (full-wave) are ideal for this purpose. Either one is readily triggered by the 100 μs pulses from the CA3059. The zero-voltage switch is designed primarily to trigger a thyristor that switches a resistive load.

Because the output pulse supplied by the CA3059 is of short duration, the latching current of the thyristor becomes a significant factor in determining whether other types of loads can be switched. (The latching-current value determines whether the thyristor will remain in conduction after the trigger pulse is removed.) Provisions are included in the CA3059 to also accommodate inductive loads.

For example, for load currents that are less than approximately 4A rms (or that are slightly inductive), it is possible to retard the output pulse with respect to the zero-voltage crossing by insertion of capacitor C_x from terminal 5 to terminal 7 as shown in Fig. 1. The insertion of capacitor C_x permits switching of loads that have a slight inductive component and

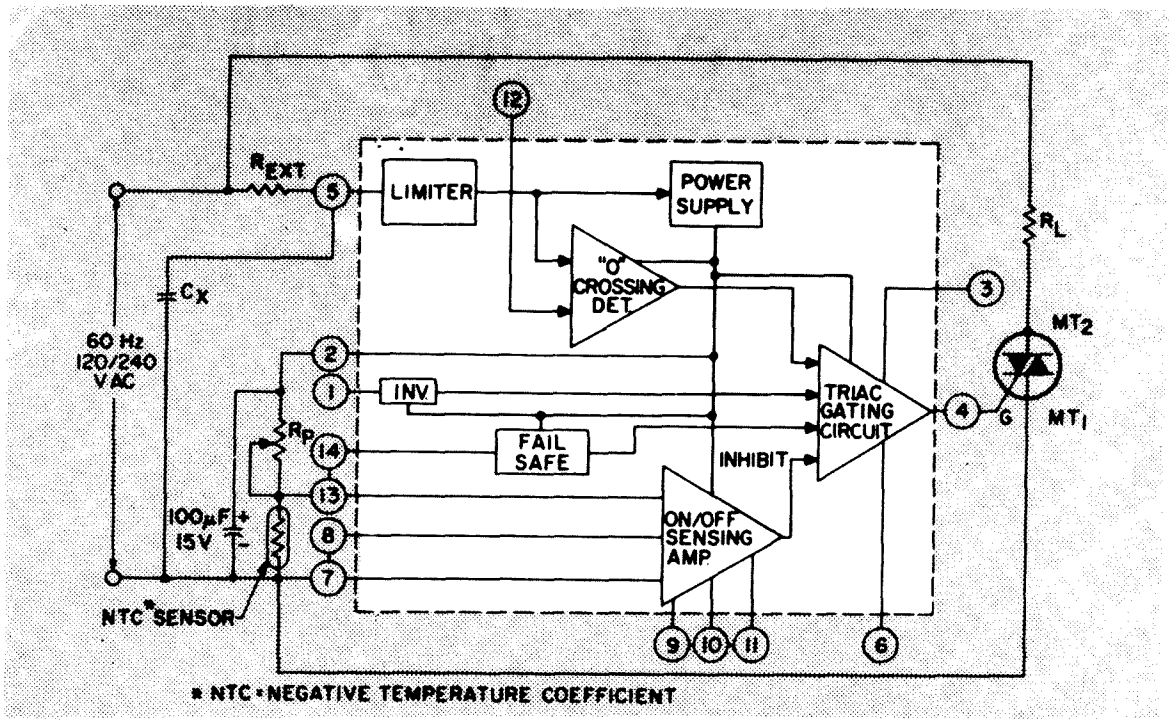


Fig. 1. Functional block diagram of CA3059. Few external components are required in this basic circuit when used to trigger the gate of a triac. The sensor may be a temperature-sensitive thermistor, a photoelectric cell, or a simple off-on switch.

that are greater power than approximately 200W. For loads less than 200W, it is recommended that the user employ the RCA-40526 sensitive-gate triac with the CA3059 because of the low latching-current requirement of this triac.

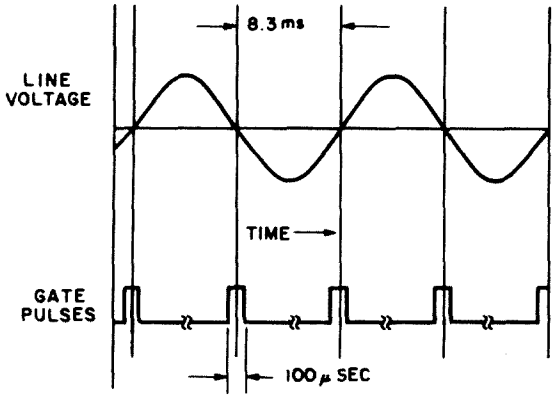


Fig. 2. Timing relationship between output pulses and the ac line voltage. Notice that the gate pulses are present to trigger the triac at zero line voltage.

Figure 3 shows an application which is useful in switching noninductive loads. Lamps and electric heaters can be controlled in this circuit by a simple switch, photoelectric cell, or temperature-sensing thermistor.

Inductive loads up to 200W can be controlled by the configuration shown in Fig. 4. In this case, terminal 12 is connected to terminal 7, and the zero-crossing detector is inhibited. Whether a "high" or "low" voltage is produced at terminal 4 is then dependent only upon the state of the differential comparator within the CA3059 integrated circuit, and not upon the zero crossing of the incoming line voltage. Of course, in this mode of operation, the CA3059 no longer operates as a zero-voltage switch. However, for many applications that involve the switching of low-current inductive loads, the amount of RFI generated can frequently be tolerated. This curcuitry is particularly useful as a differential comparator. Such comparators have found widespread use as limit detectors which compare two analog input signals and provide a go/no-go output, depending upon the relative magnitudes of these signals. In many industrial control applications, a high-resolution, fast switching unit is not essential. The CA3059 is ideally suited for use in such applications.

The chart below compares some of the operating characteristics of the CA3059, when used as a comparator, with a typical high-performance commercially available IC differential comparator.

PARAMETERS	CA3059	Typical IC Comparator
1. Sensitivity	50 mV	2 mV
2. Switching speed	>20 μs	90 ns
3. Output drive capability	4.5V at ⩽4 mA	3.2V at ⩽5 mA

The CA3059 can be used as a simple solid-state switching device that permits ac currents to be turned on or off with a minimum of electrical transients and circuit noise.

The circuit shown in Fig. 5 is connected so that after switch S1 is closed, electronic logic waits until the power-line voltage reaches zero before power is applied to the load. Conversely, when the switch is opened, the load current continues until it reaches zero.

This circuit can thus switch a load at zero current regardless of whether it is resistive or inductive. The maximum load current that can be switched depends on the rating of the second triac. If it is an RCA-2N5444, an rms current of 40A can be switched.

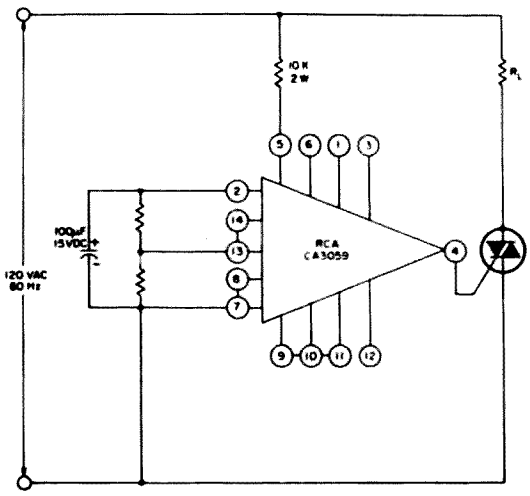


Fig. 3. Controller for resistive loads. The RCA 2N5444 triac can be used for load currents up to 40A. The RCA 40668 triac will switch intermediate loads and the 40526 will handle lighter loads and those which are somewhat inductive.

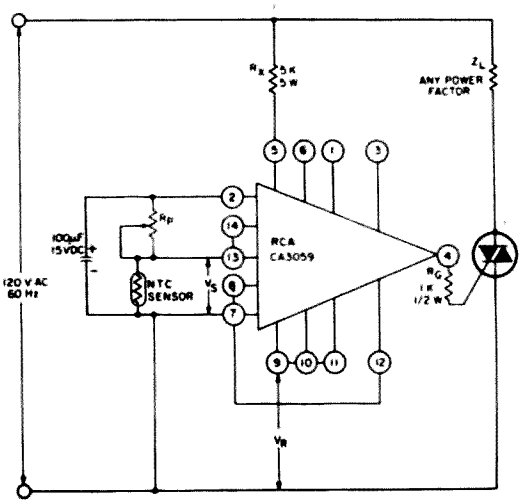


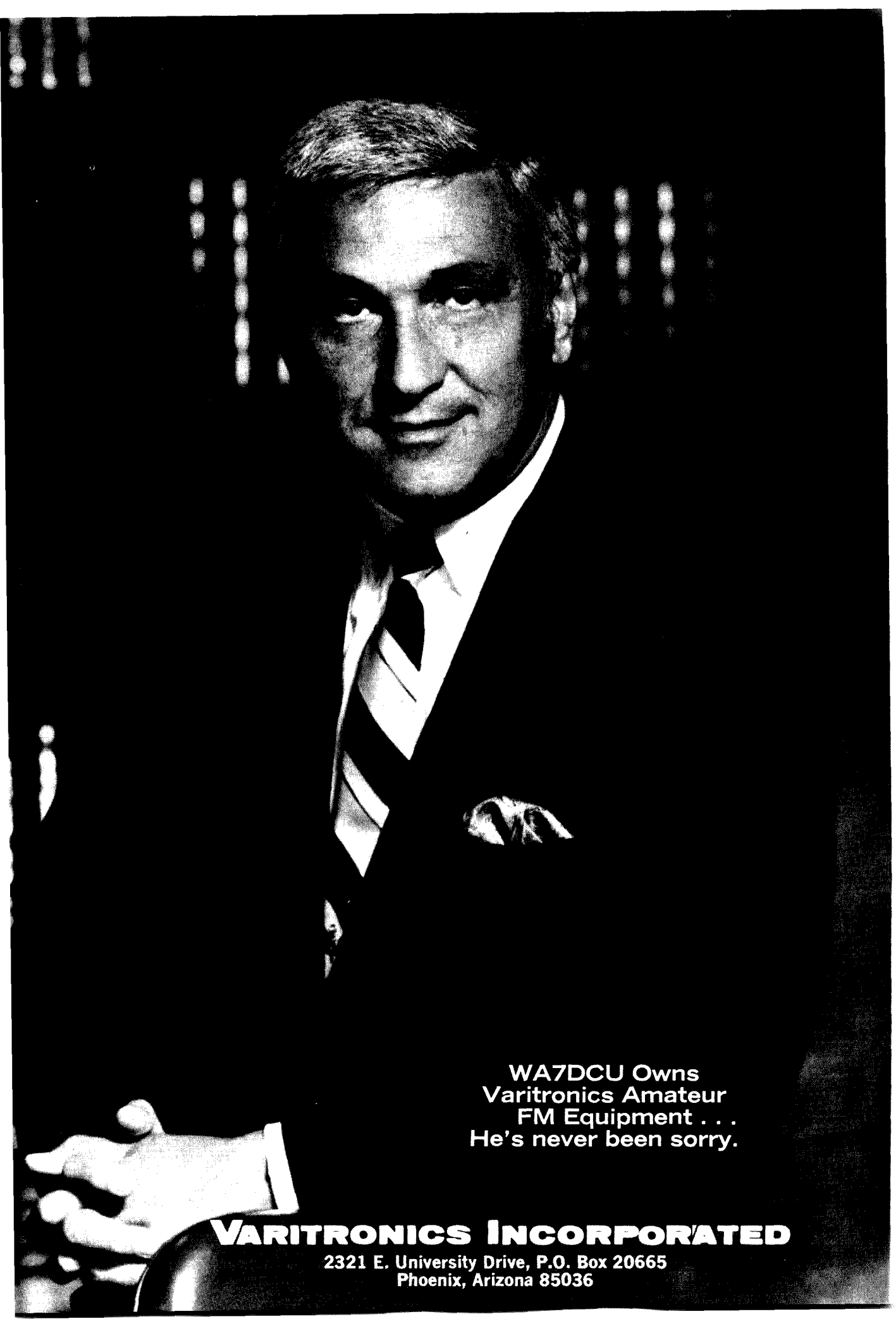
Fig. 4. Differential comparator circuit. The load is switched on when the voltage difference between V_S and V_R becomes less than 50 μV. Note the jumper between terminals 7 and 12, which deactivates the anti-RFI feature.

Figure 6 is a schematic diagram of the CA3059 zero-voltage switch. This should prove helpful to the more advanced experimenter who wishes to design his own circuits for specific applications. Some of these may include:

- Relay control
- Heater control
- Valve control
- Lamp control
- Photosensitive control
- Synchronous switching of flashing lights
- Power one-shot control
- On-off motor switching
- Differential comparator

By referring to the schematic and to the functional block diagram of Fig. 1, we can identify the following circuits within the zero-voltage switch:

1. Limiter, power supply – permits operation directly from an ac line.
2. Differential on/off sensing amplifier – tests the condition of external sensors or command signals. Hysteresis or proportional-control capability may easily be implemented in this section.
3. Zero-crossing detector – synchronizes the output pulses of the circuit with the time of zero-voltage in the ac cycle to eliminate RFI when used with resistive loads.
4. Triac gating circuit – provides high-current pulses to the gate of the power controlling thyristor.


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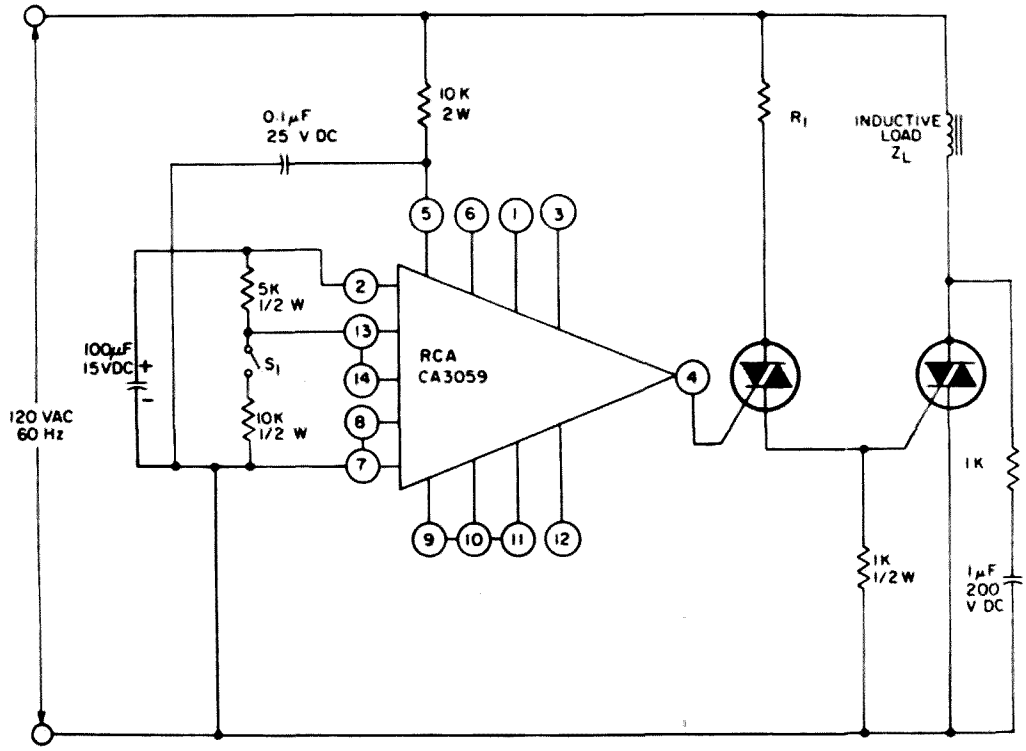


Fig. 5. Practical power switch. Heavy inductive loads can be handled by adding the 0.1 μF capacitor and by cascading the two triacs (RCA 40526 and2N5444). With the latter heavy-duty triac, R1 should be the highest suitable value less than 10 kΩ.

In addition, the CA3059 also provides a built-in protection circuit which may be connected to remove drive from the triac if the sensor opens or shorts. And thyristor firing may be inhibited through the action of an internal diode gate connected to terminal 1. In addition, high-power dc comparator operation is provided by overriding the action of the zero-crossing detector.

Additional information is available in RCA specification sheet File 397 and companion application note ICAN-4158.

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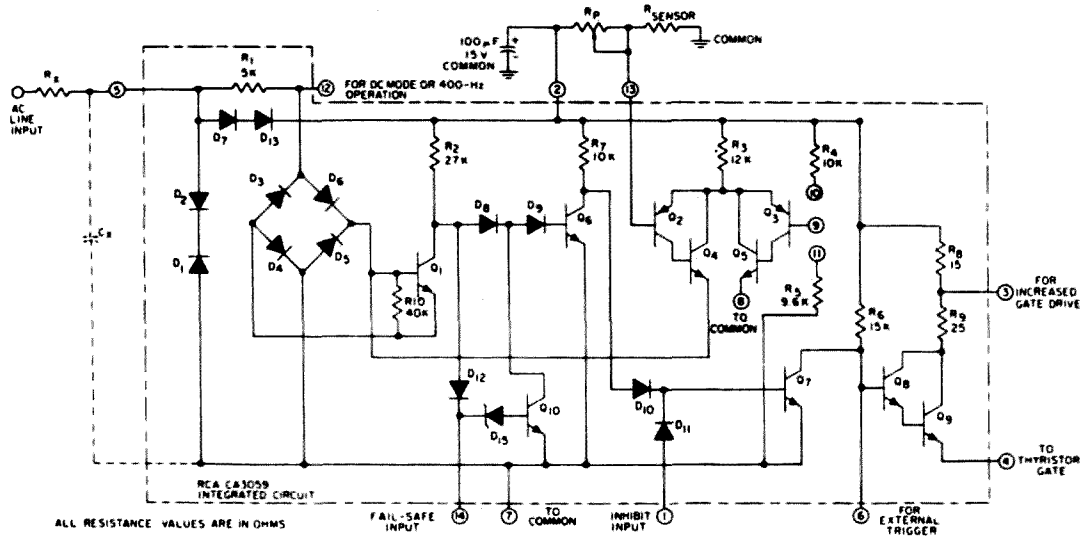


Fig. 6. Schematic diagram of CA3059 zero-voltage switch. This miniature device contains the equivalent of 10 transistors, 14 diodes, and 10 resistors.

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E. E. Krebsbach pictured in recent years at the KGCX mike

The scene is eastern Montana, circa 1926. Seated before a roll top desk on which is stacked a small but complete broadcasting station and engaged in winding a hand-cranked phonograph is E.E. Krebsbach, entrepreneur of Radio Station KGCX, then located in Vida, Montana. The phonograph was vital to the operation of the station, its broadcast music being produced by the simple expedient of placing its microphone (which formerly saw service as a desk-stand telephone) in front of the Victrola.

Vida, a hamlet with a population then and now of only about fifty people was, in 1926, not blessed with electric power lines so the seven and one-half watt signal of KGCX was generated with the aid of a thirty-two volt farm light plant.

Farmers of the area, their day's work done, would fire up their crystal sets or perhaps a squawky Grebe regenerative receiver to listen to the evening's program on "that banker feller's station over in Vida." Reception was mostly via headphones except for those rare occasions when (wonder of wonders) relatively distant CKCK located in Regina, Saskatchewan, achieved loudspeaker levels with their signals. Such an event caused businessmen in the towns of the area to hurry home to bring their wives and children "down town" to hear this marvel of the Twentieth Century. The trip to Main Street was made at breakneck speeds in Model T Fords with much dust generated from the unpaved streets, lest the signal fade out before the entire family heard it (invariably their comment was "It was coming in RIGHT ON THE LOUD SPEAKER") and because in those days, there usually was only one receiver in each village, more often than not being owned by the town physician or druggist, as befitting persons representing Science in the community.

The operator of the radio receiver sat amidst a farrago of wires, dry batteries, wet

batteries, gooseneck speaker, huge loop antenna, etc., and was regarded with considerable respect in the community for his ability to snatch music and voices out of the air. The reader should understand that just anyone could not, of course, and would not be permitted to operate the radio receiver. One had to be qualified as a RADIO EXPERT. Many dials and knobs had to be manipulated precisely to bring something intelligible out of the squawks, squeals, and static crashes produced by the receiver, and if the expert was out of town, the radio was mute until he returned. The townspeople stood around it when it was operating, listening on multiple pairs of headphones all plugged into the same jack.

Telephones of the hand-cranked variety were commonplace in the villages of the area by the mid-Twenties, and the Montana mind could comprehend how talking across miles of wire was accomplished. The process of radio broadcasting, however, was not so easily understood. It was something tinged with wonder, with sheer magic, with unbelievability that a man could speak into a microphone and *be heard miles away without benefit of any connecting wires between the two points.* A radio tuned to Krebsbach's station was set up on a kitchen table (the humble origin of the table was disguised by a generous use of bunting draped around it) at a school carnival in the area. One Scandinavian farmer, upon being informed that the music emanating from the radio was coming through the air from Vida, declared emphatically that "SUCH A TING YUST CAN'T BE DONE" and explained the whole phenomenon away as being accomplished with the use of a phonograph concealed under the table's bunting.

Early operation of the station was extremely informal, and the financial rewards small. Krebsbach once accepted a rooster as fee for advertising a sale of roosters. In the absence of telephones, farmers often used it to communicate with their homes.

Picture in your mind's eye, if you will, a distinguished silver-haired United States Senator with a white-vested expanse of abdomen of senatorial proportions, clutching the telephone mike in a well-manicured paw, and in all seriousness, campaigning for re-election over KGCX. Some weeks later, his challenger also spoke over the station, but the strength of the signal on that occasion was weak, due to a loose screw in the station's antenna system (which was all of forty feet high) and unjustified complaints of bias on the part of station management were heard.

Vida was by far, the smallest town in the U.S. that had a standard broadcast station. Radio maps of the United States issued by RCA about 1927 show a vast expanse of Western territory devoid of dots representing broadcast stations except for the one designating KGCX.

In addition to lacking electric power lines, indoor plumbing (to this day, it is still equipped with what the flowery French call *"chalets de necessite"*), and a number of other metropolitan conveniences, Vida also suffered from a lack of public transportation, inasmuch as it wasn't served by any railroad or bus line.

In other words, you just couldn't get there.

Unless perhaps you could hire someone in Wolf Point, Montana, the nearest railhead, to make the trip to Vida in an open touring car, but in the spring, summer and fall seasons the road was often a sea of mud, and in the winter it was apt to be "drifted in" (a local colloquialism meaning the road is blocked with snow drifts) with the temperature standing at thirty below zero.



Here E.E. Krebsbach is pictured operating KGCX's first transmitter in 1926 at Vida, Montana.

Vida's inaccessibility caused visits of the District Radio Inspector (whose home base was Seattle) to be rare, although he was supposed to make an inspection of the station every six months. About 1928, however, Krebsbach received a telegram re-

questing that he meet the Inspector's train at Wolf Point the following morning at 9 A.M. Hurried long-distance telephone negotiations by Krebsbach arranged for a First Class operator to arrive at Wolf Point on an 8 A.M. train and the trio (Owner, Engineer, and Government Inspector) drove out together to the First State Bank of Vida, where the Inspector retired to another room with his equipment to make certain tests after leaving instructions to turn on the transmitter and to transmit a musical selection. He heard plenty of carrier wave, but no modulation whatsoever. Understandably flustered by the presence of the Inspector, Krebsbach had forgotten to remove the receiver hanging from the converted telephone-microphone, which short-circuited the mike and prevented any music from being broadcast. This difficulty was corrected, only to have the RI discover that KGCX was regrettably occupying a position on the radio dial twenty-two kilocycles away from the spot assigned to it by the Department of Commerce in far-off Washington, D.C. Since contemporary broadcasting stations are now required to maintain their frequency within twenty *cycles*, this was an error roughly equivalent to a London-bound jet landing in Capetown through an error in navigation. The Inspector's last words before boarding his return train to Seattle were, "I set your frequency—now don't fiddle with it."

In 1929, the station received permission to move to Wolf Point (population 2,500) contingent upon increasing its power to 250 watts. Mr. Krebsbach mail-ordered the required parts for the new transmitter and as a promotion stunt, displayed the various components of the new transmitter-to-be in the show windows of Wolf Point's stores. Even the local Chinese restaurant got into the act; the big plate transformer made a fine prop against which to lean the fly-specked menu.

Bert Hooper, Chief Engineer of CKCK in Regina, Canada was summoned to Wolf Point to assemble the new transmitter which he did in three days and three sleepless nights.

It looked it.

Hooper traveled to Wolf Point by means of an open cockpit Tiger Moth airplane, leaving Regina on a Sunday, which was a windy, gusty day so typical of the upper Midwest. It was necessary to have a man hanging on each lower wing of the aircraft to steady it until it gained speed for take-off. Navigation on the flight consisted of flying low enough to read the station names on the prairie railroad depots. Upon reaching the International Border a stop was, of course, mandatory to comply with the requirements of Customs and Immigration laws. However, the actual Boundary itself does not, in the subject area, consist of an impenetrable fence and a gate with barber-pole stripes as depicted in the movies. Rather, it consists of nothing but open and endless prairie land, marked every half mile with a concrete post and with Russian thistle "tumbling weeds" blowing back and forth from one country to the other in utter disregard of protocol. In those days, the Border officials were not stationed at the Boundary itself but rather at the nearest town to the border, which in this case was Scobey, Montana, some sixteen miles south of the International Line. Since Scobey, or for that matter, no other town in the area had an airport, a handy cow pasture was used as a landing field. In landing, the plane narrowly missed several holes excavated by gophers and arrangements were made to avoid such a stop on the return flight by an agreement with the border officials that flying twice around the Scobey water tower would constitute sufficient identification.

ONCE around would have been more than enough, since unidentified airplanes were sighted in that area and era only slightly oftener than Halley's Comet.

While Scobey had no airport, it did have two airplanes, owned by nearby farmers who agreed to escort the Canadian plane to a safe (?) landing field in Wolf Point. Now let Mr. Hooper continue the story as related in a recent letter to the author: "There were two Jennys (American and Canadian World War I training planes which two farmers had bought in Minneapolis for $50 each) that took off with us from Scobey to guide us to Wolf Point. One pilot wore a brilliant red silk shirt and the other pilot a brilliant yellow one. They flew alongside us on the

left side. With the up and down air currents, one minute we were looking down at them in their cockpits and the next moment they would be above us. Those Jennys were equipped with OX 5 water cooled engines and were a bit slower than us so we had to throttle back. It was a wonderful sight. . .We collected the various components which Ed (Krebsbach) had placed in the various store windows for advertising and I went to work. The pilot, Ted Holmes, was anxious to get back to Regina, so I worked around the clock until nearly daylight, around 3:15 A.M. Wednesday morning. Just missed a herd of cows in taking off, and to avoid them (we didn't see them until it was almost too late), Ted pulled the stick back into his stomach and we missed the power lines by an inch. We got back to Regina about 6 A.M. The Moth was equipped with an inverted six cylinder air-cooled engine of the latest English type and we could do all of 90 mph. I still think of those farmers and admire them for their nerve in buying two surplus training planes for $50 and flying them to their farms in Montana from Minneapolis. No licenses were required in those days. Must admit I did a lousy job in building the transmitter, but if I could have had a night's sleep and more time, I could have done a much better job. The plane was needed back in Canada to fly somewhere to pick up a sick person and fly him to a Regina hospital.'" (Author's note: Mr. Hooper did an *excellent* job, considering the very short time he had available to build a complete broadcasting station. The wonder is that he could do it at all in three days. The transmitters he built for CKCK were absolutely beautiful in appearance and performance. The $50 purchase price of the war-surplus airplanes referred to included three flying lessons. "Graduation ceremonies" from the miniscule flying course consisted of a handshake from the instructor who then pointed in a generally west by northwest direction and said "Montana is thataway.")

It will be related later in this story what excitement was caused in the towns of the area by an airplane circling overhead. It is easy, therefore, to imagine the carnival atmosphere instantly created in Wolf Point that hot and dusty Sunday afternoon when

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not only a single airplane, but *three* of them started circling the town with obvious intent to land.

Incidentally, Hooper had passed his First Class radiotelegraph operator's examination at age 15 while he was living in Vancouver, B.C. and employed there as a telegraph messenger boy. Shortly afterward, he arrived home for supper one evening to find instructions awaiting him to report as Radio Officer aboard a vessel due to sail at 8 o'clock that evening. An obliging tailor worked overtime to cut a foot or so off the trousers and sleeves of a Radio Officer's uniform to make it fit young Hooper, who was slight of build, and gold thunderbolts affixed to the telegraph company's cap completed his uniform. He rode his bicycle to the dock, arriving at 7:45 P.M., carried the bicycle aboard and in his haste, reported to the Captain with his right trouser leg still furled around his ankle and held in place with a bicycle clip, and became perhaps the youngest "Sparks" ever to sail the seas.

The new transmitter tried hard to look like the latest product of RCA, but (reflecting its hasty construction) the whole effect was touchingly like that of a small boy's drawing of his conception of what a transmitter looks like.

It worked fine.

A tragic note in the history of the station occurred when an operator was electrocuted when he tried to replace a filter condenser in the high voltage supply without interrupting the program.

One of KGCX's more dramatic services to its listeners was to warn ranchers of the area when the nearby and treacherous Missouri River was on one of its rampages. Ol' Big Muddy has a nasty habit of changing its channel without warning, and in the spring, it often piles up chunks of ice, some as large as an automobile, with resultant flooding behind the ice jam.

Basketball was, and still is, a leading divertisement in the small towns of the upper Midwest during the long bleak winters, which hardly ever last more than seven or eight months. (An old cliche in the region has it that the climate of the area can be described as being eleven months of winter, one month of poor sledding, and thirteen months of wind.) Once, when Wolf Point High School was playing Poplar, Montana, the gymnasium was filled to absolute capacity by an enthusiastic crowd. KGCX's announcer, unable to gain entrance, had to borrow a step-ladder and peer through a transom to watch the game and broadcast the play-by-play account. When Wolf Point reached the finals in the state basketball tournament, local pride was outrageous and coverage of the final game was demanded of and provided by KGCX. A telephone was set up on the playing court at Great Falls, and a reporter relayed an account of the game to an announcer in Wolf Point who broadcast the game. One ardent Wolf Point fan, unwilling to wait for the broadcast version of the game, slipped unnoticed into the KGCX studio and was monitoring the reporter's account of the game on one of the station's extension telephones. When he heard the final score he shouted "WE WON" so loudly it blasted the transmitter right off the air. It was an hour before repairs could be made and the station could give its listeners the final story of the game.

One Saturday evening when the Krebsbach's were out of town (when the cat is away, etc.), an out-of-state dance orchestra (Duke Snyder and His Happiness Boys) which was barn-storming the area, dropped in at KGCX to provide some live entertainment. With the aid of a large supply of Montana moonshine, the Boys lived up to their name, and along with the technician operating the station, became progressively Happier as the evening wore on, and stayed on the air all night, a distinct departure from normal station policy. The hilarity knew no bounds and as the percentage of alcohol in the blood of the musicians increased, so did the tempo of the music. The human nose can detect and classify over 16,000 odors. Whether alcoholics can smell the fusel oil in liquor from afar or whether they are unerringly guided to a source of free liquor as surely as the honey bee is directed toward the nectar of the flowers by some not-yet-understood sixth sense, is as yet unknown, but in any event, several of the town lushes soon increased the size of the party. Large platters of fried oysters, fetched from the nearby Hotel Sherman, supplied the

calorie energy to keep the festivities going at full blast until they were reluctantly stopped on Sunday morning with fond farewells (performed as only a drunk can) on the part of all concerned, *only* because of the necessity for the station's engineer to run in a broken-field stagger that would have delighted the late Knute Rockne with the station's only microphone to one of the town's churches to cover a regularly scheduled Sunday morning church services broadcast. Some of the local merrymakers, stoned beyond ambulation, remained draped over the studio chairs and leered glassily at all comerss, while the orchestra retired to its sway-backed bus, which had a particularly apt-to-break-down-any-moment look about it, to sleep it off in time for their evening performance.

In Wolf Point, the station was associated with an oil company and located in that firm's service station. The clatter of a tire iron, unfortunately dropped on the concrete floor when the mike was open, would occasionally assail the ears of KGCX's listeners. Nevertheless, the station continued to fill a need in the area and in 1936 was granted a power increase to 1,000 watts.

KGCX dominated the air in its domain in more than one way during the late Twenties, since the oil company maintained (as a public relations device) an airplane which roamed over an area a couple of hundred miles in all directions from Wolf Point and which had the box-car size letters "KGCX" painted on the underside of the lower wing. As previously intimated in this story, the appearance of ANY aircraft in the area's sky was cause for great excitement and if it landed, the pilot NEVER had to walk into town, since shortly after landing he and the airplane would be surrounded by a crowd of the townspeople, who had driven out for a closer look at the flying machine and the Superman who could actually make it fly. The pilot, a somewhat taciturn individual who was reported to have laughed aloud once in 1919 or thereabouts and who was cross-eyed beyond any hope of surgical correction, occasionally cracked up the plane upon taking-off or landing and such an occurrence was, of course, THE thrill of the summer for the village, surpassing in excite-



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SENSITIVITY: 100 mv rms, 25 hz to 25 mhz; 500 mv, 10 hz to 25 hz; 200 mv, 25 mhz to 30 mhz. Maximum input, 50 v rms or 200 v peak AC plus DC. Input impedance approx 20k ohms shunted with 40 pf. Has input gain control. Ratio input (rear panel) 200 mv rms, 100 khz to 20 mhz.

TIME BASE ACCURACY: Room temperature 1 mhz crystal standard. Aging rate, ±1 ppm/week. Temperature stability, ±5 ppm 50 to 90 degrees F.

RANGES: FREQUENCY – four gate times, .001 sec to 1 sec. Decimal point indicated for kilohertz. PERIOD – three standard frequencies counted: 10 khz, 100 khz and 1 mhz. Decimal point indicated for milliseconds. RATIO – 100 khz to 20 mhz. Resolution selected by range switch. SCALING – 100 khz to 20 mhz. Division in decades from 10 to 1,000,000, selected by range switch.

MARKER OUTPUT: Fast rise square wave; 1 hz to 1 mhz in decades selected by range switch. Output is 4 volts open circuit, .2 volts into 50 ohms. Harmonics to hundreds of megahertz for receiver calibration.

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ment and over-the-backyard fence conversations even such great events as the visit of the Yankee-Robinson Railroad Circus With 500 People And 200 Animals, or the erection of the tent for the annual Chautauqua. The writer remembers attending something called a "rally" with his father at the site of an oil (?) well near Mohall, North Dakota, at which A.C. Townley, a Huey P. Long in microcosm, was the attraction and who arrived via airplane, which "buzzed" the crowd for dramatic effect before landing. To be able to shake hands with Townley was, for many a farmer in attendance, worth a trip ten times the distance. Upon being queried as to whether he was successful in shaking hands with the Great Person, one farmer was heard to reply, "No, but I TOUCHED his sleeve." Doughnuts and coffee, the latter conveniently heated with the bona-fide natural gas genuinely issuing from the well, were served following which samples of oil were extracted from the well (in tomato cans lowered on a string) to further on-the-spot sales of oil stock by the promoters. The great advantage of the well in question was that it produced oil already refined. A digression to include the Townley story was made only to assure the reader that had it been advertised merely that an airplane would be on hand, with rides going for a dollar a throw (without any celebrity being present), a large crowd, albeit not as huge, would still have attended. Thus the choice of an airplane as an advertising gimmick for both the oil company and KGCX was a brilliant one.

KGCX's antenna actually spanned the main street of Wolf Point, with the transmitter- studio- service station building and one antenna tower on the north side of the street and the other windmill type tower situated in a park-like setting on the south side of the street. This arrangement caused the maximum signal to be radiated in an easterly and westerly direction, directly at the most populated areas of the world. Too, the "flat-top" antenna (a type no longer used these days) was very conducive to the production of sky-wave signals which might be reflected back to earth from the Kennelly-Heaviside layer of the ionosphere thousands and thousands of miles from the little Montana town in which they were generated. In those embryonic days of radio, there were few stations on the air and consequently little or no interference between stations. Therefore, once the signal was started on its way from Wolf Point, there was nothing to stop it and it might fall back to earth in Tokyo or Tangiers or Tampa, depending on "skip" conditions and Mrs. Krebsbach mailed out many a printed Official Confirmation postcard from KGCX upon frantic requests from DX listener hobbyists living thousands of miles distant from Montana. It takes but little projection to place oneself in their shoes and imagine their fascination with such an exotic-sounding name as *Wolf Point, Montana*, bringing visions of timber wolves, Indians astride Pinto ponies attacking the military outpost, etc., to the mind of a listener, for example, in New York City who had never been west of Philadelphia. Remember, this was back in the Twenties and it wasn't a great span of years since such events had actually occurred in the area in question.

The unusual placement of the antenna towers caused hardship for a KGCX relief operator who arrived in Wolf Point via evening train at the height of a Montana blizzard. (It is useless to try to describe to those readers who have spent their lives in Southern climes what carnival Mother Nature engages in during these prairie storms, which usually claim the lives of several persons each winter. Suffice it to say that visibility is often cut to five feet or perhaps less.) This engineer, now an official of the Federal Communications Commission, located the "wrong" tower (the one in the park) and spent a freezing and fruitless half hour in the storm searching for the nerve center of the station. The possibility that KGCX was literally "working both sides of the street" never occurred to him. With all stores closed (what manner of customer would venture out in such weather?) no one was around to help the lost engineer and it was only by sheer accident that he stumbled into the other tower across the street and into the safety of the transmitter room.

Sparse population in the Wolf Point area, coupled with adverse business there, precipitated a financial crisis for the station in the

early Forties. With total station income for the year 1941 down to only five hundred dollars, it was obvious that *something* had to be done, and quickly. Eyeing a map of the area, Mr. Krebsbach wisely decided that a move to Sidney, Montana (population 5,000) with establishment of auxiliary studios in Williston, North Dakota (population 10,000) was the solution, and the Federal Communications Commission agreed. The move was accomplished in 1942. A complication arose when a major piece of the equipment which had always performed beautifully in Wolf Point, stubbornly and positively refused to work at all in Sidney.

In 1948 KGCX secured another power increase which required the erection of a second tower to protect another station hundreds of miles away from interference by KGCX. A consulting engineer was imported to Sidney to properly locate the new auxiliary tower. After much computation with his slide-rule, he selected the exact spot and the big job of erecting the two-hundred feet high structure was completed. When the last turnbuckle was tightened on the last guying cable, he dusted off his hands and stepped back with a smile of satisfaction to admire his work. As a final-final check, he again consulted his slip-stick. Gradually his eyes opened wider and wider until they approached the size of Satsuma plums, realizing that he had made a monumental error with the result that the whole tower had to be taken down piecemeal and re-erected at a spot some twelve feet away.

Some years later, the tower came down again (although considerably faster) with the suspected help of saboteurs.

During the Fifties, KGCX employed an announcer who, like the late Jack London's character in *Burning Daylight*, attempted to burn the candle at both ends by adopting a daily schedule of announcing all day and doing all night what comes naturally to young men. While the spirit was willing indeed, the flesh sometimes revolted from lack of rest, and the strains of Debussy's *Clair de Lune* or other soothing music from the studio speaker occasionally dropped the fledgling announcer off into the kind of sleep bordering on that from which there is no awakening, with the result that KGCX's

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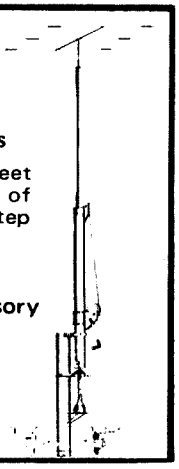
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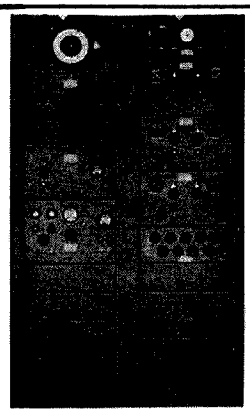
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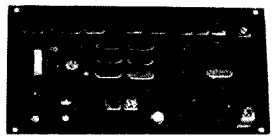
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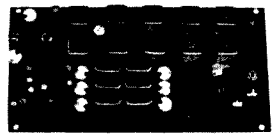
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slot on the radio dial became deathly and apparently permanently silent. On an automobile trip a hundred miles or so distant from Sidney, with his car radio tuned to his favorite station, Mr. Krebsbach noticed this state of affairs and (apparently considering it to be somehwat less than ideal) made haste to the nearest town and the nearest telephone to correct the situation. The thoughts of Mr. Krebsbach during the comatose announcer incident are not known to this writer, but I am sure his fine Christian faith remained unshaken, in contrast perhaps with that of The Poor Sisters of Perpetual Adoration, who were recently bilked of nearly two million dollars in a Texas oil scheme and who may now be possibly at least a nickle's worth less perpetually adoring.

The original KGCX transmitter has been lost in the shuffle from town to town. Still preserved, however, is the 32 v to 1,000 v motor-generator (which provided the high voltage for the type 210 final tube) its armature frozen fast, never again to help waft the music of the A & P Gypsies into the blue Montana skies.

The $125 investment in the original transmitter has paid off handsomely; this writer estimates that KGCX is currently worth at least a third of a million dollars and perhaps more.

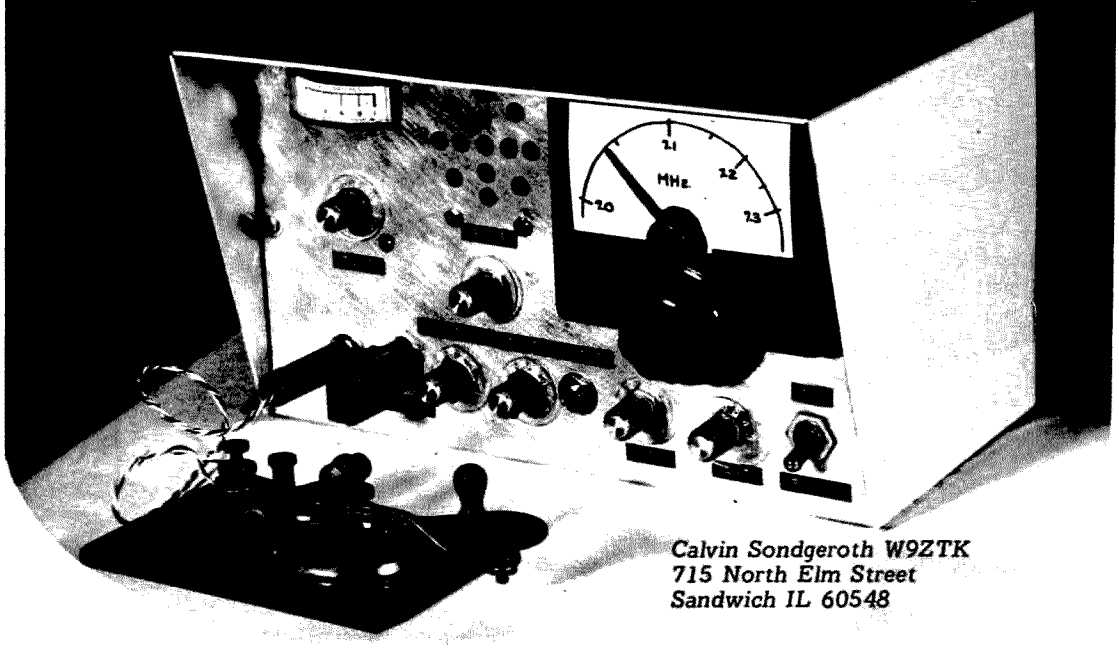
With comic incidents long past, modern equipment operating dependably, and with financial problems solved, the seven and one-half watt baby has grown into a powerful five thousand watt giant which blankets a large area with its Mutual network and local programs.

Fortune has smiled twice upon Wolf Point since, for the second time, it had a radio station thrust upon it when, in 1957, after business conditions had improved there, Mr. Krebsbach returned to his old stamping grounds after an absence of fifteen years and built KVCK there, a one-thousand watt sister of KGCX.

Mr. Krebsbach, although in declining health, continues as this is being written as owner and General Manager of KGCX and deserves the heartiest of congratulations for building his station from a back-room hobby into the respected and important entity it is today . . . W6CXC

THE SST-I

solid state transceiver for 40 meters



Calvin Sondgeroth W9ZTK
715 North Elm Street
Sandwich IL 60548

This is the age of the transceiver in ham band operation. Although there are many medium- to high-power commercial SSB packages available with self-contained transmitter and receiver, there is not much to choose from for low-power CW work. This article describes a small unit which is solid-state and provides about 2W input with a self-contained battery power supply. The receiver is simple but quite effective for CW work, and its performance matches that of the cheaper superhets. All the components are readily available and no special parts were used in the design. Since the transmitter is crystal-controlled, this little rig would make an ideal beginning station for the Novice.

Receiver

A QST article by D. DeMaw (May 1969) described a solid-state direct conversion receiver using an RCA linear integrated circuit. This design requires a minimum of parts for CW (and sideband) reception since the incoming signal is mixed with a local oscillator at the signal frequency for audio output directly from the product detector. Although the selectivity is not as good as a superhet with i-f conversion, the results are entirely adequate for general operation. The receiver far outperforms any superregenerative set I have built, and I've tried many circuits.

The front end is double-tuned to prevent responses on strong signals outside the 40 meter band; two toroids tuned with a 140 pF double-section variable capacitor accomplish this, as shown in the transceiver schematic, Fig. 1. The incoming signal is lightly coupled to the IC product detector to prevent loading the input circuits, and the local oscillator uses an identical toroid in its tuned circuit. The oscillator circuit is tuned by a 50 pF variable with a small trimmer in series to adjust the bandspread to cover the full 180 degrees on the dial.

Audio from the detector is coupled out through a small transistor interstage transformer with a 10 kΩ potentiometer across the secondary as a gain control. A single stage of audio amplification precedes the audio amplifier, which is the push-pull audio section salvaged from an old transistor broadcast radio. This generates plenty of audio to drive a small loudspeaker (also from the BC set); and if just headphone operation is desired, the 2N3391A will provide enough output by itself.

The original article on this receiver used an audio bandpass filter between the detector and the audio amplifier. This had two large toroids and, in the interest of size reduction, a low-pass filter consisting of a single LC section provides adequate cutoff of high-frequency hiss and noise which is present without any filtering at all.

The inductance in the filter is the secondary of an interstage audio transformer shunted with a 0.1 μF capacitor to ground; this arrangement cuts off around 2000 Hz. The capacitance value can be adjusted to provide proper cutoff with the particular audio transformer used. The receiver is usable without the filter, but the high-frequency components in the detector output become annoying after an extended period of operation.

It will be noted that two 9V batteries are shown on the schematic to power the receiver section. This was done because the *rf–first audio* portion used a negative ground system while the push-pull output of most of the small imported radios uses a positive ground system, and the output transformer secondary has one side tied directly to ground. Various ground arrangements were tried to eliminate one of the batteries, but the two-battery setup was finally decided upon. This does split up the load on the batteries somewhat and increases their life. The rf portion draws about 15 mA and the audio section anywhere from 10 to 50 mA on strong audio peaks.

CW Monitor

A unijunction audio oscillator is included on the audio output module for monitoring while transmitting. The monitor output is fed into the audio output amplifier after the gain control, and the monitor level is set for suitable volume which is independent of the receiver volume control setting. Voltage for the monitor is obtained from the transmitter supply and it is keyed along with the transmitter.

The 100 kΩ resistor and the 0.01 μF capacitor in the emitter lead of the unijunction provide an audio tone of about 600 Hz; this can be raised by lowering the value of the emitter resistor if you prefer a monitor pitch of higher frequency.

Transmitter

The transmitter, crystal-controlled for simplicity, used three 2N697 transistors – two in the rf section and the third as a switch for keying. The keying switch was added to reduce the current through the key contacts, although it could easily be eliminated and the final connected to the negative supply continuously, since it does not draw any current without drive from the oscillator. The keying arrangement shown was a result of using the transmitter which had already been built when the transceiver idea came up.

The oscillator is connected in a Pierce circuit with the crystal between collector and base. The 1 kΩ potentiometer in the emitter controls the drive to the final. The oscillator collector uses a slug-tuned coil with a small link wound over the cold end to the couple into the final amplifier.

The final, operated without any bias, runs class C. It uses a *pi* network in the output circuit,

SWR Bridge and Meter Circuit

For tuneup while operating portable it was considered desirable to include some means of monitoring final collector current as well as some way of indicating when a match to the antenna was obtained, since random-length antennas are convenient. A small pilot light could be used to indicate relative current in the final, but the addition of the 0–1 mA meter and the swr bridge has proved its worth in the field.

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The meter is set by a three-position switch to read either final-stage emitter current or forward or reflected power. For emitter-current readings, the voltage across a 10Ω resistor in the emitter lead gives a full-scale reading of approximately 100 mA with the meter specified. A 20 kΩ potentiometer is connected in series with the meter for swr measurements and must be set to zero resistance for final current indications.

The swr bridge is standard in design except for the two transistors added as dc amplifiers. They were found necessary to get indications with the low power output of the transmitter. The gain mismatch between transistors does not really allow the swr to be measured accurately, but a good indication of a proper match to a 50 or 72Ω coax line can be obtained by adjusting for minimum reflected power and maximum forward power. A two-section switching arrangement could be used to eliminate one of the transistors, thus providing more accurate readings. The bridge conductor is a piece of ¼ in. copper tubing; the pickup wires are of 14 AWG solid wire. The assembly is built in a small channel bent up out of aluminum sheet metal as shown in Fig. 2. In order to get readings with the bridge it must be mounted off the main chassis with an insulating spacer and the channel connected to ground via the coax shield on the input and output only.

Construction

The main housing for the transceiver is a Bud SC-3030, which is 6 x 10 x 7 in. This volume allows construction without crowding yet keeps the unit small enough to be easily portable. The transmitter is built on a separate minibox 2¼ x 2¼ x 5 in. and can be put together as a separate unit with a couple of leads provided for a crystal socket on the front panel of the main enclosure. The transmitter is mounted to the front panel by the key jack which has one side tied directly to ground. In addition, a barrier terminal strip was provided on the rear panel for connection of an ac power supply for fixed station work. The drive control potentiometer was mounted inside the transmitter since it is not adjusted in normal operation. The final amplifier transistor was mounted on a piece of .040 aluminum about 2 in. square which serves as a heatsink. Since the collector is connected to the transistor case, the heatsink must be insulated from ground.

A twice-size PC board layout for the receiver *rf--first audio* section is shown in Fig. 3. The integrated circuit is soldered directly into the circuit board, although a socket can be used. Don't be too concerned about damaging the integrated circuit. The one here had to be removed from the board once by cutting the leads above the board and remounted by soldering extension leads to it indicating that these little devices are really quite rugged. Without a proper unsoldering tool, it is difficult to remove the IC once it has been soldered in so a socket might be a good idea even though the board is not laid out for one.

To facilitate parts placement and circuit identification, the composite layout/schematic of Fig. 4 is included. This should help to speed your final assembly process.

The audio output amplifier from the discarded broadcast set was mounted on a small piece of Vector board along with the components for the CW monitor. Fortunately, the radio I dismantled had been built in two sections, with the audio stages on a separate small circuit board. Other radios might have to be operated on to get just the audio section to use in the transceiver. The input to the amplifier can be located by tracing down the leads going to the volume control in the original radio. The wiper arm on the control is connected to the input.

The receiver modules are mounted to a small subchassis which was extensively worked on with tin shears. It is made from a standard open-end 5 x 7 x 1½ in. aluminum chassis. The front is cut off to clear the controls on the front panel and the rest notched and cut where necessary to clear the main enclosure. A vertical shield was positioned across the transceiver between the receiver and transmitter, although this is probably not absolutely essential.

The subchassis provides adequate mounting space at the center (between receiver and transmitter) for the transmit-

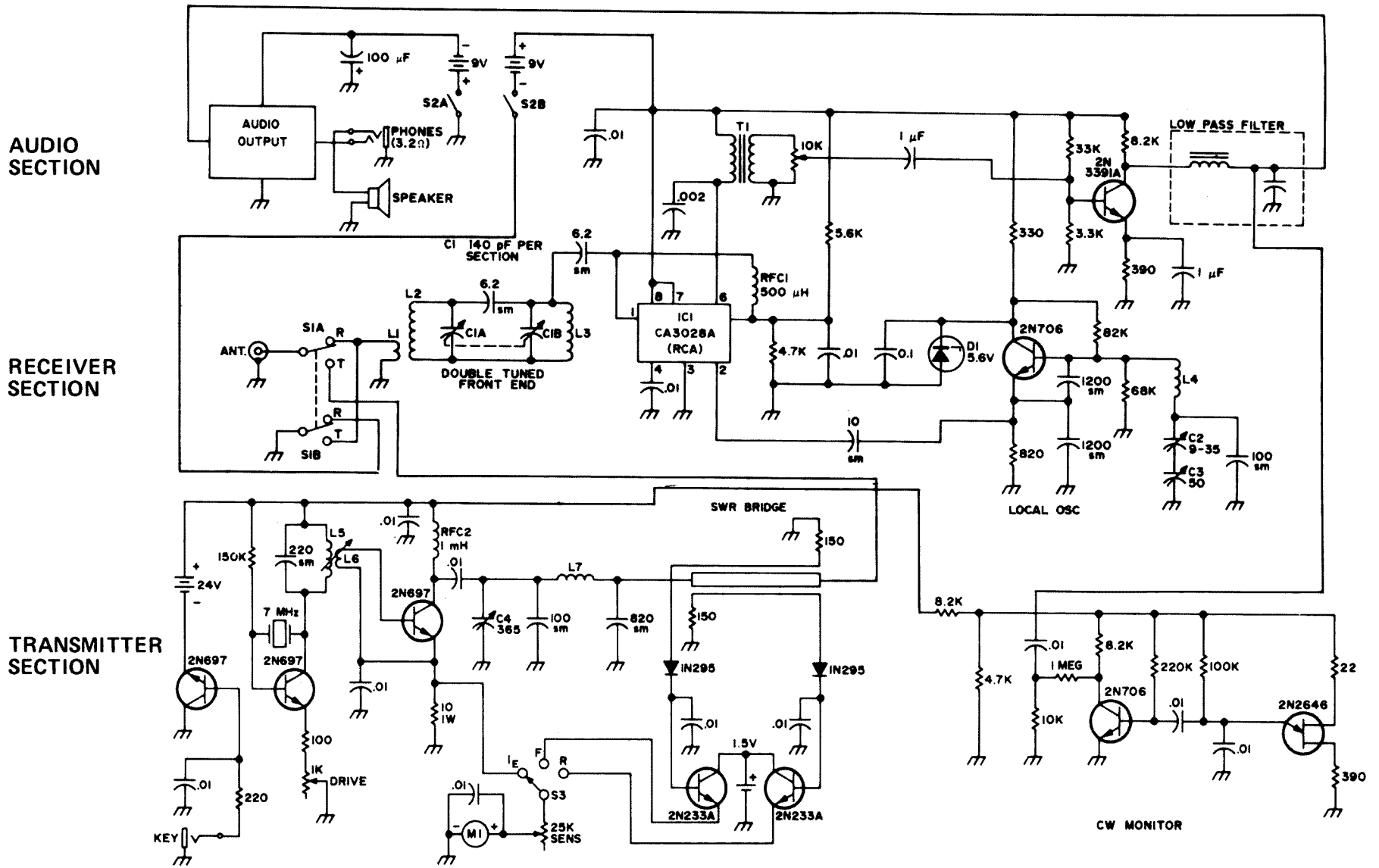
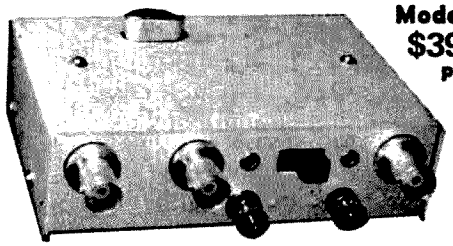


Fig. 1. Schematic diagram of solid-state 7 MHz transceiver.

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ter batteries and the two 9V batteries are mounted to the rear enclosure wall with a homemade bracket of sheet aluminum. The 1.5V penlight cell is mounted on the swr bridge channel as shown in Fig. 2.

The swr bridge is mounted near the rear of the transmitter and the bridge channel is insulated from the main enclosure as mentioned above. Connection to the bridge should be made with small coaxial cable going to the transmitter *pi* network and the transmit–receive switch. Similar coax is used to connect the receiver and antenna connector to the switch.

The photographs show the general construction and panel layout used, but other builders may find other arrangements more desirable. The general layout is suggested as a logical one.

Adjustment and Tuneup

When the receiver is operating, the oscillator frequency is adjusted to cover 40 meters by alternately padding the tuned circuit with fixed capacitance and varying the trimmer in series with the main tuning capacitor to achieve the desired bandspread. By setting the trimmer, the entire

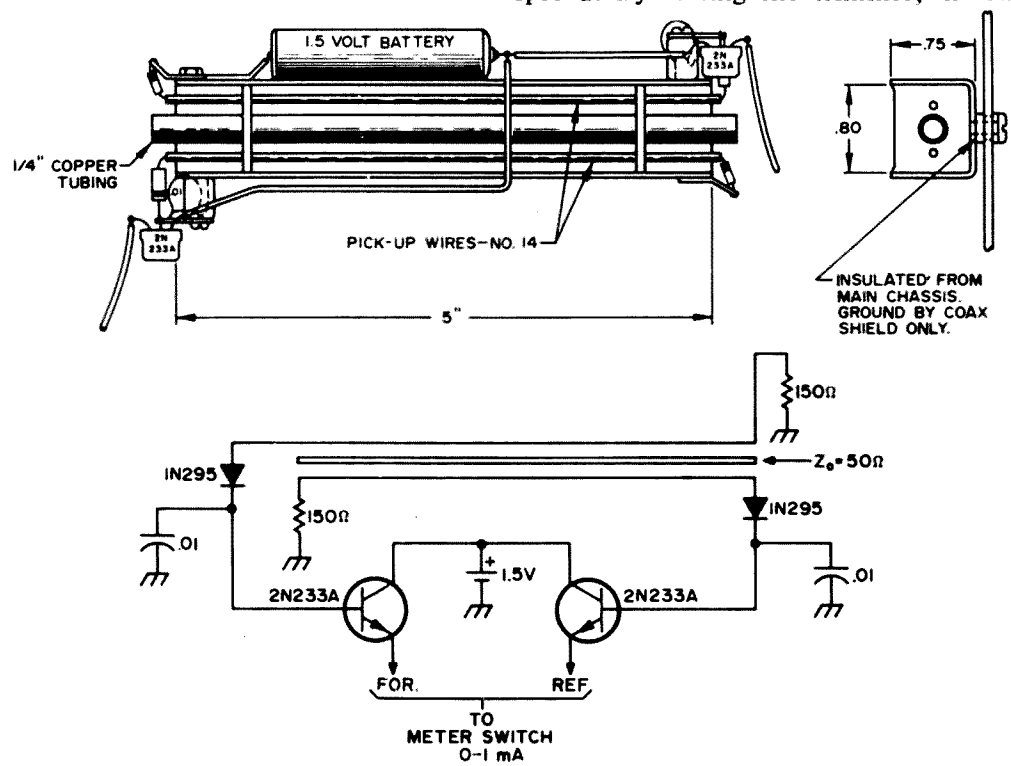


Fig. 2. Swr bridge assembly and placement data.

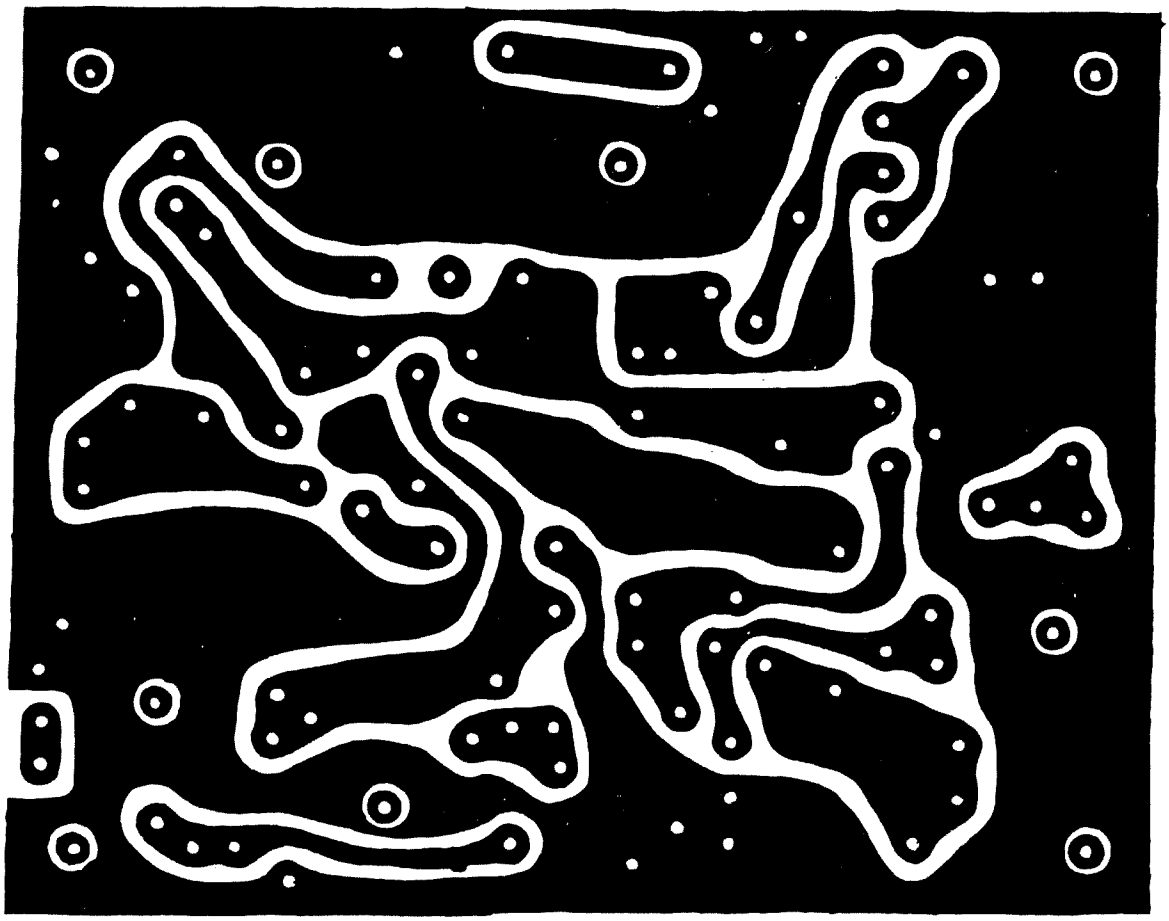
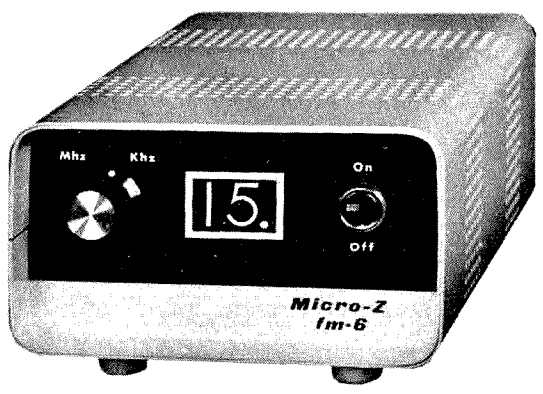


Fig. 3. Double-size PC board layout for the rf/af section of the receiver.

band can be tuned or the bandspread limited to just the CW portion. Other arrangements might give different bandspread, but the transceiver described covered the first 100 kHz of 40m over about half the dial and the other 200 kHz over the second half, which was felt to be about right and allowed for monitoring sideband as well as CHU just above the top band edge for time checks as an added bonus.

Some trouble with the local oscillator was experienced at first: Spurious responses were obtained, with 7 MHz appearing at several places on the dial. This indicated that the oscillator was operating at too high a level, which generated unwanted outputs. The two capacitors in series from base to ground on the oscillator determine the amount of feedback and the values were set as shown so that the oscillator provides just enough signal to beat against the incoming signal.

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The audio output section and the CW monitor can be checked by connecting the monitor to the transmitter supply and making sure that the audio tone is of the desired level and pitch.

When first tuning up the transmitter, it is a good idea to disconnect the final amplifier until the crystal oscillator is operating properly. The oscillator collector coil slug should be tuned up for proper oscillation and keying. With the final connected turn the drive control pot for minimum drive (maximum resistance) and switch the meter to read final emitter current. (The transmitter should have a dummy load connected during all tests!)

With the oscillator working, increase the drive to the final and adjust the oscillator coil slug and the drive control for around 100 mA of emitter current with 24V collector supply. This gives a little over 2W input to the final and is the normal level for CW operation. A 51Ω (1W) resistor makes an ideal dummy load and it should get warm to the touch after several minutes dissipating the output from the transmitter. A No. 47 pilot light can also be used as a load for indications of maximum output and should light to about full brilliance when the rig is properly loaded up and tuned.

When proper operation into a dummy load is verified, the transmitter can be connected to an antenna and the matching network adjusted in the usual way for proper loading. It is possible to QSY over 100 kHz of the CW portion of 40m without retuning either the crystal oscillator or final amplifier, with only a slight readjustment of the antenna coupler.

Results and Afterthoughts

Results with this little transceiver have

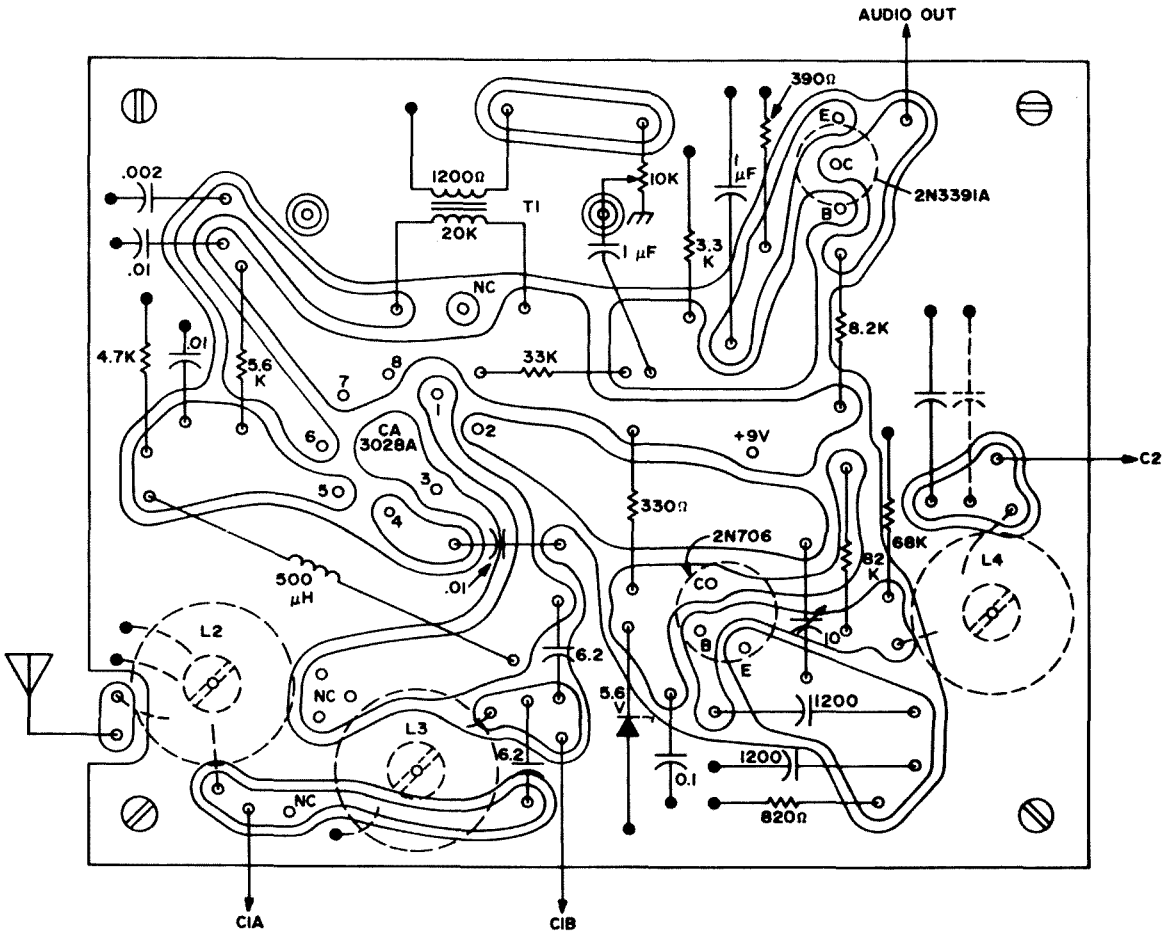


Fig. 4. This composite sketch shows positioning of components on the etched board.

been very good. A watt of power into the antenna may not seem like a lot to the kilowatt operator, but don't underestimate the punch of the signal. I have had stations at 400 miles during daylight operation insist on giving me a 599 report. In general, stations come back to the first call (unless you're covered up by a higher power station calling) and your contact probably won't know you are QRP until you tell him. Crystal control does limit the operating convenience somewhat with low power.

Since the receiver has an oscillator right on the operating frequency some will probably wonder why it is not used as a transmitting vfo also. The answer is that it can and if I were building this unit again I would probably include vfo operation. In fact, some checks were made using the receiver oscillator as a rfo with moderate success. However, the output of the local oscillator is quite low and it was necessary to provide a comple of stages of rather high gain to properly drive the transmitter. These tended to be somewhat unstable in operation and the vfo idea was abandoned, without too much work done in that direction. A conversion-type receiver would probably be better in this respect with the vfo operating at a frequency different than that of the transmitter.

With a suitable antenna coupler or matching network the rig will load into just about any piece of wire for portable work. Operation from the home station has been with a Windom antenna cut for 40m and fed with single wire. This still requires an L-network between the transmitter and antenna for proper matching. A coax fed dipole should work connected directly to the transceiver antenna connector.

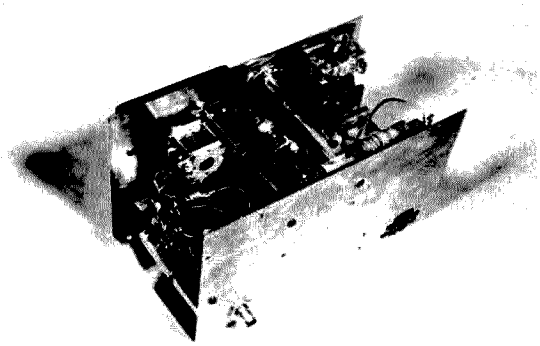


Photo showing shielding and construction of 40m transmitter and receiver in main chassis housing.

Receiver performance has been exceptional and sure beats using a regenerative set with its limited audio output and instability. Drift from a cold start with this receiver is practically nil and it can be used to copy sideband signals with no trouble at all. For CW work, a more selective audio bandpass filter can be used either in place of the low-pass filter inside the transceiver or in the headphone line. A couple of 88 mH toroids and some 0.5 μF capacitors will increase the selectivity markedly when connected as an audio filter. For general operation the filter is not necessary and it does prevent good copy on sideband signals.

With the addition of a balanced modulator, this setup could provide the basis for a simple little sideband rig using the audio section for the speech amplifier, generating a double sideband signal at 7 MHz.

Using currently available transistors, this little transceiver can be used to drive a class C stage to 15 or 20W for a little more signal, but at these power levels a battery of rather monstrous proportions is required; the 2W power level is just about right for the mercury batteries used. And 20W isn't really QRP anyway.

Table of Parts

C1 – 140 pF peri section, dual variable capacitor
C2 – 9–35 pF ceramic trimmer
C3 – Main tuning 50 pF variable capacitor
C4 – 365 pF broadcast variable
CR1 – 5.6V zener, 1N708 or equivalent
T1 – Interstage audio transformer 1.2–20 kΩ 6-T-12 PC (Allied Radio)
BA1, BA2 – 9V batteries
BA3 – 5V cell
BA4 – Two 12V batteries in series, Mallory TR289 or equivalent
IC1 – RCA CA3028A
L1 – 5 turns 28 AWG spaced over L2
L2, L3, L4 – 36 turns 32 AWG wound on .380 diameter toroid core (Arnold A4-380-125-SF)
L5 – 12 turns 28 AWG close-wound on 3/8 in. diameter slug-tuned form
L6 – 3 turns 22 AWG over B+ end of L5
L7 – B&W Miniductor ½ in. 16 TPI, 1 in. long
M1 – 0-1 mA meter (Emico Model 13)
Main tuning dial – Millen Type 10039 midget panel dial

. . .W9ZTK■

A LOW-COST RF WATTMETER

Marc Leavey WA3AJR
9412 Adelphi Road
Adelphi MD 20783

You say you just finished building that 2 meter rig and want to find out how much power you're running but can't afford to buy a wattmeter? You've been calling "CQ 80 QRP" all day with your quarter-watt wonder and nobody is answering? Then get yourself up, go down into the workshop, and build yourself a neato-keeno handy-dandy wattmeter.

If we are going to build a wattmeter, let's consider what we want. Accuracy and ease of calibration, as well as simplicity in construction are prime requisites. The meter described here is as accurate as components allow, and it's easy to build. The calibration is logarithmic, which means that a simple graph is possible, and easier than changing the meter scale.

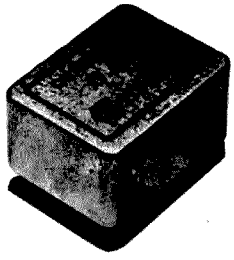
For the mathematicians, I will present the formulas upon which this device is based, and ways of modifying it; for those of you who avoid math whenever you can, look at the graphs and skip these few paragraphs.

To spare undue complexity, assume 51Ω line – other values can be dealt with later. Perhaps the easiest parameter to measure, and one that is proportional to power, is rf voltage. A voltmeter can be made most easily with a series resistor and a 0–1 mA meter. Now let's plunge into the actual calculations.

Assume W is the full-scale meter reading in watts, Z is the line impedance, E is the voltage measured, I is the full-scale meter reading in amps of the basic meter, and R is the value of the series resistor in ohms. We know that the voltage (IR) is equal to the square root of "impedance times power," or 14.270V. Now, since the voltage and the current (.001A because the full-scale movement is 1 mA) are known, simple division yields 14,270. The resistor value, then, is 14.270 kΩ. The upper portion of Fig. 1 is a graph that will enable the nonmathematician to choose the value of the resistor for full-scale readings up to 4 kW, with 51Ω line and a 0–1 mA meter.

Why 4 kW with an amateur power limit of 1 kW? A look at the bottom half of Fig. 1 will explain. Although this is the calibration of the prototype, for 4W full scale, it will double for 40, 400, or 4000W. A half-scale reading, 0.5 mA, corresponds to 1W (1 kW, etc.). This spreads out the range below 1 kW for ease of reading and measuring.

Now get out that soldering copper and gas pliers, and build it. As the schematic (Fig. 2) shows, the circuit is a basic rectifying type rf voltmeter. The prototype was built in a small can of the plug-in-module variety that was scrounged from the junkbox. About the only critical part is the series resistor. The capacitors in the prototype were mica, but ceramic disks



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Insertion Loss	<3 dB	<3.5 dB	<3.5 dB	<3.5 dB	<3 dB	<5 dB
Input-Output Termination Z_t	500Ω	500Ω	500Ω	500Ω	1200Ω	500Ω
Input-Output Termination C_t	30 pF	30 pF	30 pF	30 pF	30 pF	30 pF
Shape Factor	(6:50 dB) 1.7	(6:60 dB) 1.8 / (6:80 dB) 2.2	(6:60 dB) 1.8 / (6:80 dB) 2.2	(6:60 dB) 1.8 / (6:80 dB) 2.2	(6:60 dB) 1.8 / (6:80 dB) 2.2	(6:40 dB) 2.5 / (6:60 dB) 4.4
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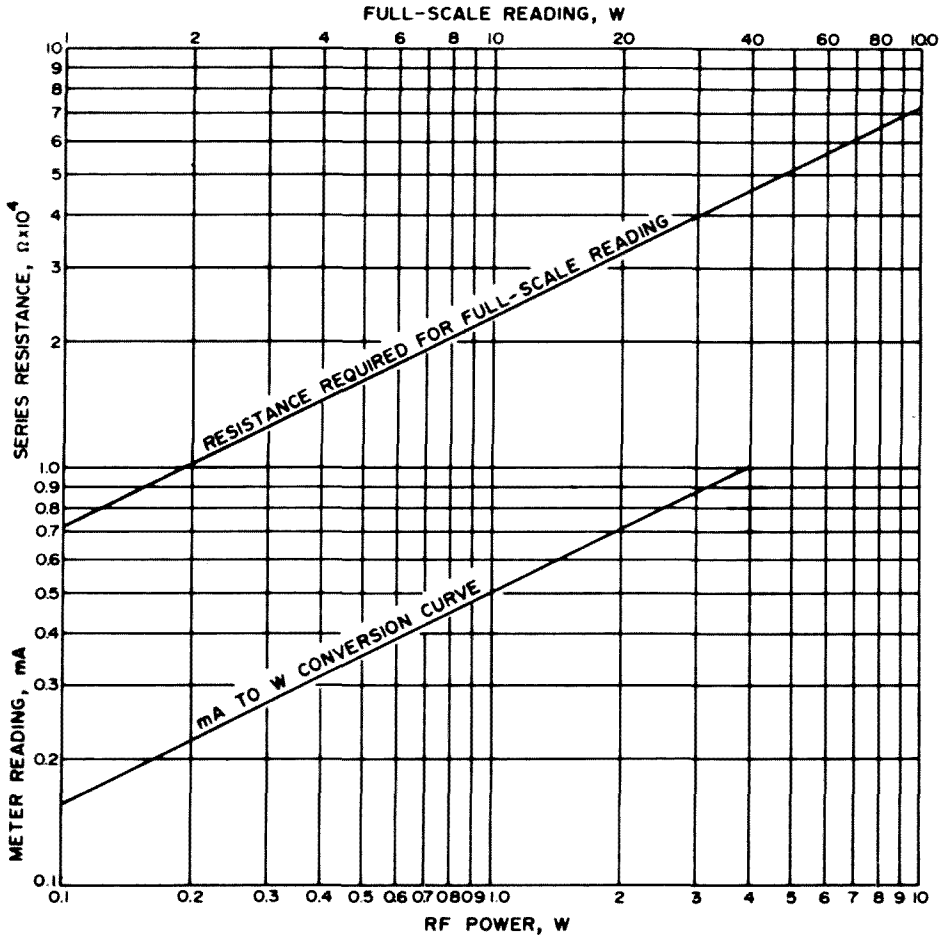
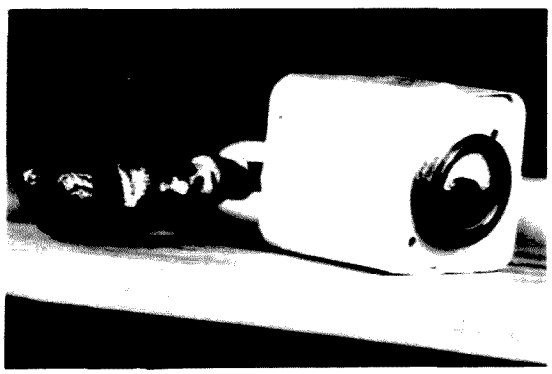


Fig. 1. Logarithmic plots for determining power. The upper curve gives resistance values for determining what the full-scale meter deflection will be (remember to multiply the series resistance value shown on the chart by 12 kΩ). The lower curve will allow you to determine your precise power out if you use a 0–1 mA meter.



Front view of unit.

as shown. Conventional minibox construction or building into a new or existing rig will be more than adequate. Point-to-point wiring is used to permit compactness and reduce lead length.

"Fine," you say, "but I don't have a huge mound of test equipment. How do I calibrate it?" That is the beauty of it – you don't! If the series resistor is accurate, the meter will be self-calibrating to a log scale. Remember, you know R and Z, and the full-scale W. Now assume a half-scale

would work as well. The diode can be a 1N34A, 1N270, 1N52, 1N38A, or just about anything else. Use the old ham's rule of thumb: "When in doubt, try it out!"

Two sockets might prove more convenient rather than one with a coaxial tee

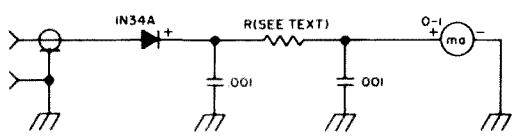


Fig. 2. Schematic diagram of the simple, accurate, and easy-to-build rf wattmeter.

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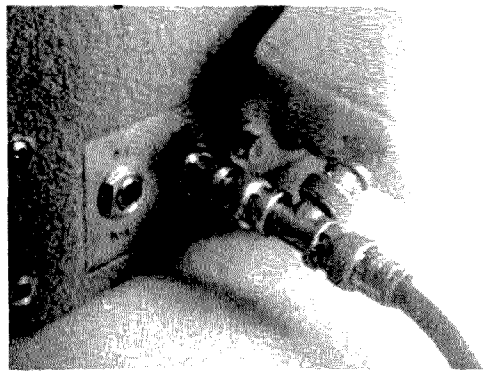
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Connection to transmitter with dummy load (see text).

reading, I = 0.0005, and calculate W for half-scale. Plot these two points at 1.0 and 0.5 mA on Fig. 1, and connect by a straight line, which you may extend the length of the graph.



Connection to transmitter with antenna connected.

Install the meter through a coaxial tee at your antenna connector, or through some other predetermined means, and terminate with a dummy load. The one seen in the picture is three 150Ω resistors in parallel, dipped in epoxy, shielded with a copper braid, and installed on a BNC plug. Apply power and read the meter. That's it! The meter can be used with an antenna if your swr is below about 1.2:1.

So what did I promise? A low-cost, rf wattmeter that is inexpensive enough for the Novice, practical and useful enough for the General, and "Extra" accurate. Go raid the junkbox, and add a worthwhile piece of gear to your shack.

. . . WA3AJR ■

Mitchel Katz W2KPE
147-11 76th Avenue
Flushing NY 11367

Calibrate that Calibrator

Most modern receivers and transceivers in use today rely upon a 100 kHz crystal oscillator to calibrate the tuning dial. While some of the calibrators are built in, others come as outboard accessories. In any event the operation of each is the same.

By this time we all probably know what "zero beating" is. The 100 kHz oscillator in order to serve as a calibrator must be "zeroed" to some standard frequency such as the WWV carrier frequency on 5, 10, 15, 20, etc. MHz. With a CW or AM receiver, we can very easily tune through the zero beat point. On SSB receivers because one of the sidebands is missing we can only hear the one side as we approach zero. The other side of zero is greatly attenuated and may possibly not be heard at all. To further complicate matters for us in trying to calibrate the 100 kHz oscillator, as we can only hear down to about 20 Hz, we can't zero in any closer than this. Leaving the receiver at this point, we next turn on the 100 kHz calibrate oscillator. After a suitable warm up period, we turn the tune control of the oscillator and again adjust for a zero beat condition against the WWV frequency. With this method of calibration we have several possible sources of error. First in zeroing WWV with the receiver beat frequency oscillator and then zero beating the 100 kHz calibrator against the bfo. Each of these adjustments is limited to the lower limit of our hearing range, as well as the fact that we are obtaining the zero beat at a relatively low i-f frequency.

A more accurate method of calibrating the 100 kHz oscillator will now be discussed. After the receiver and calibrator oscillator have been warmed up for about 30 minutes, tune in WWV on a frequency that produces a fairly good, steady signal. Adjust the tuning for maximum reading on the S-meter. Having tuned in WWV, turn *off* the beat frequency oscillator. Now turn on the 100 kHz oscillator that is to be calibrated. If a harmonic of this oscillator is fairly close to the WWV frequency, a beat note will be heard. At this time adjust the calibrator "crystal tune" control and the S-meter will start pulsing from a maximum to a minimum value. The closer you get to dead center the slower the pulsing action will become. It is fairly easy to come down to 1 pulse per second with this method. If your receiver doesn't have a meter, you can also hear this pulsation very clearly. In any event you would always tune for the slowest pulse rate.

Note that with this method we have adjusted the calibrator frequency harmonic directly to the WWV carrier rather than to a low i-f. We have eliminated one zero beating step, and this, together with the fact that we are obtaining the zero beat at a much higher frequency, will provide greater accuracy.

Having described the method, here are a few points of general interest:

1. Before attempting any calibration let the equipment heat up for at least a half hour to stabilize.

2. After tuning in WWV, wait until the 400 Hz modulating tone goes off before adjusting the calibrator. If not, you may find later that you zero beat the 400 Hz instead of the carrier frequency!

3. The levels produced in the receiver by WWV and the calibrator oscillator should be about equal to produce a good beat between the two frequencies.

4. Use the highest WWV frequency that will produce a good, stable signal in the receiver. Certainly a 1 pulse per second beat at 20 MHz will provide greater calibration accuracy than 1 pps beat at 5 MHz or better yet than 455 kHz! The accuracy will be considerably greater and it is no more difficult to come by.

Mitchel Katz **W2KPE** ■

STUDY GUIDE GENERAL CLASS LICENSE

Part IV: Got a Match?

Nope, we're not discussing the relative health hazards involved in tobacco, gasoline, and kitchen matches – even if we will be using many of the same words. In this chapter, we're concentrating on three major subjects: impedance matching, how filters operate, and transistors.

Up to now, we have established the basics of ac and dc circuit theory to sufficient depth to permit us to cover this broad range of subjects this time. While the subject range is broad, it accounts for only three questions on the FCC's official study list. They are (numbers, as always, are those appearing in the list):

7. What is impedance matching and why is it important?

23. How can transistors be used in electronic equipment? What is the beta of a transistor? Compare the elements of a transistor to a vacuum tube's.

42. What do high- and low-pass constant-k filter circuits using balanced and unbalanced pi- and T-sections look like?

For starters, we'll attempt to discover why and how impedances are matched. This exploration may shock a few old-timers as much as it shocked us during the research stages – because the "why" is, it turns out, rather different from the reasons most popularly believed.

Then we'll turn our attention to filters, with two question: *What is a filter?* – which should bring some order into the names applied to filters as well as uncovering their various uses (and many disguises), followed by *How do filters operate?* This second query which will examine the means by which the more common circuits accomplish their purposes.

With matching and filters accounted for, we can take up transistors – but to provide some groundwork in this area, we'll first explore amplification and bring all kinds of amplifiers into our picture of circuit theory. With that established, we will be in much better position to examine the question *How do transistors amplify?*. This will take care of the other transistor details involved in the FCC question as well.

It's a big bite of information this time, so let's get right into it. Take a deep breath, and we'll be on our way. . .

Why and How Are Impedances Matched?

In previous chapters, we have put together a number of different types of electrical circuits, building each circuit up from different kinds of components. In every circuit, we have had a "generator" or power source of some sort, together with the passive components which make up the rest of the circuit.

In examining these circuits, we have seen that the action of the entire circuit depends upon the relations between the various components which make up the circuit. If any single component is changed, the circuit's action changes. In other words, for any circuit to act as its designer expects it to, every part of the circuit must be what it was intended to be.

Now we can take any single component, or a group of several components which go together to make up a subcircuit, and draw an imaginary line separating that part of the complete circuit from the rest. Having done this, we can name the part of the complete circuit which contains the power source as the *source* and the other part of the circuit as the *load*. Doing this does not change the fact that it is one complete circuit, so that every part must still be what it was intended to be for the expected circuit actions to occur.

In particular, any variation of component values or types in the *load* will

affect operation of the *source* just as it would when we looked at the whole thing as being a single circuit.

In practice, almost every electrical or electronic device is an *incomplete* circuit. Only the simple circuits which we study to learn how things work are complete and self-contained in themselves. A factory-built transmitter, for instance, does not come from the store complete with its own 117V ac generator, nor is the antenna a part of the rig as you purchase it. For the transmitter to operate, you must connect it to a power source, and you must provide an antenna as the rig's load.

The importance of impedance matching stems directly from the fact that all practical circuits are incomplete, and must be completed by the user in order to operate. To complete the circuit, the items connected by the user must "match" the equipment – and yet the equipment designer cannot possibly predict exactly how every possible user may connect his product.

The situation is saved by the fact that impedance can be considered to be a constant factor. That is, any circuit which exhibits a specific impedance characteristic can be substituted for any other circuit which has the same impedance characteristics. This is sometimes called the *black box* theory; the name comes from the fact that if you conceal a circuit inside a black box which cannot be opened, the only method anyone has of determining what is inside the box is to measure its performance at the terminals which connect it to the outside world – and all circuits which show the same characteristics in such measurements can be considered to be identical to each other no matter what is actually inside the box.

By specifying the required impedance levels for the power source and the load, then, the equipment designer can assure the user of his product that it will perform as intended.

In its most-used sense, the phrase "impedance matching" means simply providing the required impedance level, and says nothing about what this impedance level may be. In some cases this may mean providing a high impedance compared to the source, and in some cases it may mean a low impedance. The important thing is that the *required* impedance is provided, and it's up to the equipment designer to say what this required impedance may be.

However, impedance matching may also mean other things, and that is where the confusion comes in. One of the most respected ham radio reference books puts it – incorrectly – this way: "It is possible to show that any source of power will deliver its maximum possible output when the impedance of the load is equal to the internal impedance of the source. The impedance of the source is said to be *matched* under this condition."

The error is easy to see if we take the circuit of Fig. 1, in which the impedance of

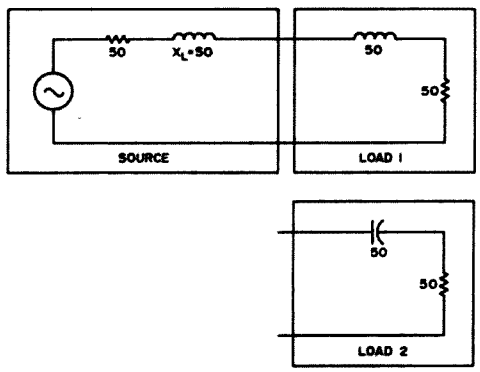


Fig. 1. Differences between "image impedance" matching and "maximum power transfer" matching are shown here and discussed in text. Using "load 1" follows the image-impedance rule, in which load's impedance is exact duplicate of source impedance. You can see that reactance is present, reducing power from the maximum possible. Use of "load 2" follows "maximum power transfer matching" rule in which resistances match but reactances are of opposite polarity. Reactance then cancels, and power is at maximum.

the source is 50+j50 ohms (inductive reactance as well as resistance). If we match this with a 50+j50 ohm load, the total impedance applied to the generator will be 100+j100 ohms. The 100Ω resistance is accompanied by another 100Ω of inductive reactance, and if the generator supplies

100V rms we will get a current through the resistance of only about 700 mA. This 700 mA through the 50Ω resistance of the load will develop a potential of 35V and the power dissipated in the load resistance is 700 mA (0.7A) times 35V, or 24.5W.

If we change the load impedance to 50-j50 ohms, though, to make the reactance of the load equal in amount but opposite in sign to that of the load, the reactances will cancel each other. The circuit is now series resonant. Net impedance seen by the generator is 100±j0 ohms, and 1.0A flows. This 1A develops 50V across the resistance in the load, or a 50W dissipation.

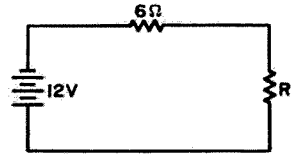
The handbook's statement is incorrect, but several generations of amateurs take it for truth. The *correct* statement is that maximum power is delivered when the resistance components are equal in amount but opposite in sign. This form of impedance matching is known as "maximum-power-transfer" matching. Of course, if neither source nor load involves any reactance, this boils down to equal impedance.

The equal-impedance type of matching defined in the quotation from the handbook is known to engineers as "image impedance" matching, because each of the impedances involved is the exact image of the other. While it does not guarantee maximum power transfer if any reactance is present, it is often employed because of its simplicity.

And as we have already noted, if pains are taken to eliminate all reactance from both the source and the load impedance, the image-impedance match and the maximum-power-transfer match are identical.

An important point to keep in mind during this discussion of matching is that we are limiting ourselves to making changes in the value of the load impedance only, and are leaving source impedance strictly alone. Only with this restriction do our rules and definitions apply.

For instance, let's take the circuit of Fig. 2, which consists of a battery, its internal resistance (drawn separately), and a load resistor. If we could vary *both* resistances at will, we would find that the maximum power in the load resistor would be achieved not when both were of equal value, but when the internal resistance was much smaller than the load resistor. With the internal resistance fixed, however, (say at 6Ω) we find that the maximum power is developed with the same value in the load. With a 12V source and a 6Ω load, we get 6W dissipated in the load. Reducing the load resistor to 5Ω makes our current 12/11A and our dissipated power 720/121W (I^2R), or 5.95W. Increasing load resistance to 7Ω makes the current 12/13A, and the power becomes 1008/169 or about 5.98W.



R	I	POWER
5	12/11	$\frac{5 \cdot 12^2}{11^2} = 5.95$
6	12/12	$\frac{6 \cdot 12^2}{12^2} = 6.00$
7	12/13	$\frac{7 \cdot 12^2}{13^2} = 5.98$

Fig. 2. When impedances are purely resistive, maximum power is always taken by load which is neither higher nor lower in resistance than power supply's own internal impedance. If internal impedance is fixed at 6Ω as shown here, then load resistance of 5Ω draws more current, but smaller resistance results in less power being taken. Load resistance of 7Ω draws less current, and again power goes down. Only when source and load impedance are equal does power taken by load reach maximum 6W level.

Before confusion becomes complete, let's review the key points we've encountered. Impedance matching has at least three meanings. The most common is *providing some specified, required value of impedance as a device's load.* The second is identified as maximum-power-transfer matching, and means to make the load impedance equal in resistance to the source impedance, and equal-magnitude-but-opposite-sign in reactance. The third, called image-impedance matching, means making the load impedance the exact duplicate of the source impedance. Finally, in case both source and load impedance are free of reactance and involve only resistance, the maximum-power-transfer and the image-impedance matches turn out to be identical to each other.

Before we move on to see how such matching is performed, let's look at some examples to illustrate the various meanings.

One ready example not directly connected with ham radio is the matching between amplifier and loudspeaker in a top-quality hi-fi or stereo system. Most of the tube-type amplifiers are rated to operate into a 16Ω load impedance, although they likely have output connectors marked as 8Ω and 4Ω. The speakers, similarly, are rated at either 4, 8, or 16 ohms. The speaker to the amplifier, we simply connect the speaker to the amplifier terminals which are marked with the same impedance value.

In actual fact, the "impedance" rating is somewhat inaccurate since it includes neither reactance nor phase angle, which we saw a while back is required for accurate specification of impedance. In addition, the true impedance of any speaker varies widely over its operating frequency range, and few if any come anywhere within 20% of their rated impedance at more than three or four spot frequencies.

These points make very little difference, because the actual source impedance presented by the amplifier is almost always far smaller than the rated impedance.

What does make all the difference is that the 4, 8, and 16Ω ratings provide a means for specifying the "black-box" characteristics of both amplifier and speaker. Any amplifier with a 16Ω output terminal can be expected to operate with any speaker rated at 16 ohms impedance, regardless of actual impedance characteristics of either amplifier or speaker.

This, then, is an example of the first meaning of impedance matching; we provide a specified, required load impedance value.

Another example is offered by the 117V power outlets in almost every home. While we usually talk about our electric power in terms of voltage or sometimes wattage (a 100W bulb, for example) this still is a close relative of the first kind of impedance matching. We know that any device rated to operate on 117V, 60Hz power will operate when plugged into a normal outlet; we don't have to specify all the electrical charateristics of the power company's generators and transformers on each electric appliance.

Maximum-power-transfer matching is the usual rule for connecting transmission lines and antennas to radio transmitters. The objective is to radiate as much of the transmitter's output as possible, which is just another way of saying "maximum" power. Antenna and feedline matching is often thought of as though it were done on an image-impedance basis – but when the normal practice of tuning the feedline to eliminate reactance is looked at in a slightly unusual light, it can be seen as a way to provide reactance of equal value but opposite sign and so to achieve max-power matching.

In fact, the whole art of matching transmission lines to antennas and transmitters *is* the art of maximum-power-transfer matching, and we will get into this type of impedance matching much more deeply when we get around to looking at antenna theory.

Despite the misconceptions held by most of us as to what an impedance match consists of –,which would indicate that the only true match was an image-impedance match – examples of true image-impedance matching are difficult to find.

Possibly the closest to this situation is the audio practice of matching all long lines to an arbitrary 600Ω impedance, initiated originally by telephone companies in order to provide a "standard" matching condition and adopted by all others who had to deal with telephone lines. Since most audio equipment rated at 600Ω actually has a slight bit of inductive reactance as well (associated with the matching transformers almost universally used to reach the 600Ω level), this type of matching meets the image-impedance definition.

Now that we've defined impedance matching in its three variants, let's see how it is accomplished:

The most common method of matching impedances is by the use of a transformer. A transformer consists essentially of two inductors coupled to each other so closely that the magnetic with the magnetic field

ARRL DIRECTORSHIPS

The ARRL elections for directors are about ready to close. Don't let the do-nothings get into office again. Make sure the fellow you vote for is devoted more to amateur radio than he is to the League.

FM'ers in the Southwest Division should be advised that John Griggs has done more to boost FM than any other director anywhere. His performance record in office has been satisfactory, the Southern California boys say, and he is responsive to the needs of amateur radio. Most important, he does not appear to be glory-hungry and he listens to the advice offered by his informed associates.

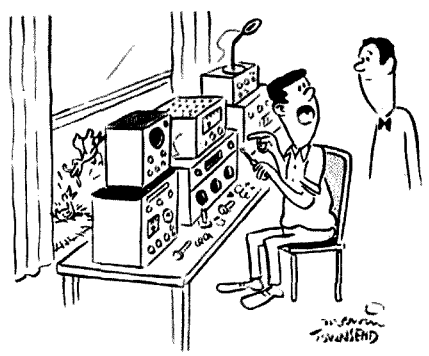
Since time is so short, there has been no opportunity to evaluate all nominees, but poor "performance in office" is cause enough to reject some of the directors who are seeking reelection. Here are a few of the directors who, in the opinion of some of our readers, are hurting amateur radio by their past performance (or lack of it):

Hudson Division
Harry Dannals W2TUK

New England Division
Robert Chapman W1QV

Central Division
Philip Haller W9HPG

Rocky Mountain
Carl Smith WØBWJ



"I can't seem to locate that peeping sound."

associated with one of them coincides with the magnetic field of the other. When this is the case, a change in current flow through the first inductor causes variations in the common magnetic field, and these variations in the magnetic field induce current flow in the second inductor. Energy is thus transferred or coupled from one circuit to another with no conductive connections; the common magnetic field does the "connecting," replacing the usual wires. Because a change in the magnetic field is necessary for a transformer to operate, the device is effective only with ac. In a dc circuit, a transformer produces one spike of energy in the output when power is applied and the initial current flow begins, and another spike of opposite polarity when power is removed and current flow begins, and another spike of opposite polarity when power is removed and current flow ceases. In between, nothing happens.

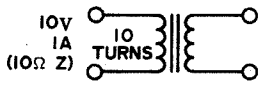
Because the transformer does its job by means of the magnetic coupling between two inductors, it introduces a 90-degree phase shift just as would any other inductor. This is usually ignored.

The transformer's ability to serve as an impedance-matching device depends upon the relationships that exist between current intensity, magnetic field strength, and inductance. We've gone through most of the necessary background when we met inductance to begin with. All we need to point out now is that the strength of the magentic field depends upon the number of turns in the inductor, and similarly the intensity of the induced current also depends upon the number of turns, but in opposite ways.

This means that if one of our inductors contained 10 turns it might develop a magnetic field strength of 10 units with one ampere of current. If the other inductor also contained 10 turns, the resulting magnetic field would induce an identical current intensity (assuming that the coupling is perfect and none of the magnetic energy goes to waste). However, if the second inductor contained 20 turns, the current intensity would be only half an ampere because each unit of magnetic field

strength would have to release its energy to twice as much wire and could only give each turn half as much. And if the second inductor were only five turns, then each unit of magnetic field would affect half as many turns, and so would produce twice the current intensity.

Keeping in mind that we're talking about a "perfect" transformer which loses no energy, all of the energy put into the circuit must appear in the output. If the input energy comes out to be a 10W rate, with 1A flowing, it must be at 10V. We get that same 10W out; if current intensity is only 0.5A, the voltage must have been increased to 20V, and if the current intensity is raised to 2A the voltage must have been reduced to only 5V. Figure 3 summarizes these points.



TURNS	I	E	Z
5	2	5	2.5
10	1	10	10
20	1/2	20	40

Fig. 3. Transformer operates by converting current changes in primary winding into changing magnetic field, and reconverting magnetic field changes which result into new current changes in secondary. Voltage, current, and impedance levels are all transformed from original values to new values which depend on the ratio of the numbers of turns in each winding. Chart shows results for three sizes of secondary winding, if primary is fixed at 10 turns, and takes 10W (1A) from 10V source for impedance level of 10Ω.

That's where the name "transformer" originally came from, because this device transforms voltage or current levels either up or down. It does so, however, without adding any energy. Any real transformer, naturally, must be less than perfect, so it will really lose a little of the input energy.

The real functions of a transformer are easier to see, though, if we think of the same thing. In an ac circuit, we use impedance rather than resistance in the Ohm's Law equation. Our sample transformer which accepted 1A of current from a 10V source represented a 10Ω resistive impedance (10V/1A). When it stepped voltage up to 20V and current down to 0.5A, it transformed the impedance level from 10Ω to 20/0.5 or 40Ω. When it stepped voltage down to 5V and current up to 2A, the impedance went from 10Ω to 5/2 or 2.5Ω.

By adjusting the ratio of the number of turns on the input inductor (usually called the primary winding) to those on the output inductor (secondary winding), any desired ratio of impedance transformation can be obtained. The rule is simple; the ratio of impedances is equal to the *square* of the number of turns in a transformer with tight coupling between winding. The square gets into the act because the ratio of voltages is the same as that of the number of turns, while the ratio of currents is the inverse of the number of turns (because current goes up as turns ratio goes down). Impedance ratio equals the voltage ratio divided by the current ratio, and dividing any number by its inverse is the same thing as squaring the number.

Normally, this arithmetic isn't necessary; the transformer manufacturers have already done it for you and any transformer you buy which is intended for impedance matching is rated by its intended impedances. You will find, though, that most are rated for specific input and output impedance values rather than by ratio. They will provide the ratio, however, in every case.

That is, if you need a transformer to match 6 kΩ to 8Ω, and have one which is rated at 3 kΩ primary, 4Ω secondary, you have the one you need. 6000:8 is the same ratio as 3000:4 or 1500:2, or 750:1.

You can also use power transformers, in a pinch, to match impedances if the ratios are close enough. To do this, convert the input and output voltage ratings into a voltage ratio by dividing the larger voltage by the smaller. For instance, a 120V to 6.3V filament transformer has a voltage ratio of 120/6.3 or almost 20:1. Convert this to an impedance ratio by squaring it; we get approximately 400:1, which is close enough. This would match an 8Ω loudspeaker to a 3 kΩ power amplifier output, or 16Ω to 6 kΩ.

Most transformers you can buy are for use at audio or i-f frequencies, but the

transformer principle is also used in rf circuits. Almost all transmitters use transformer coupling between stages, although not by that name.

The transformer is not the only method of matching impedances, but it's probably the most efficient.

Special amplifier circuits, known as "cathode followers" and "anode followers" when vacuum tubes are used and as "emitter followers" or "common-collector circuits" when transistors are employed, also have an ability to transform impedances, but they do so in a much different fashion. In general, transformer matching cannot always be replaced by special amplifiers, although in special cases they can.

One method of impedance matching sometimes used in audio and communications work is by means of matching "pads," which are circuits of series and parallel resistors so arranged that from one side of the circuit it presents one impedance level, and from the other side, another. The simplest matching pad is the resistive voltage divider, which is merely two resistors in series.

The advantage offered by the matching pad as compared to the transformer is that it is much less expensive – but this is offset in most cases by the fact that a matching pad must waste more than half the energy present in the circuit, and the greater the ratio of impedances to be matched the greater the loss in a matching pad. For an 8:1 impedance ratio, the loss is 35 dB – more than 99.9% of the energy lost! The transformer, while it costs more, rarely has more than 1 dB loss.

What is a Filter?

In any electrical circuit, it's sometimes necessary to select specific kinds of signals and separate them from other kinds also present in the circuit. In general, the devices or circuits used to do this job are known as filters. The name comes from the similarity to a physical filter such as the oil filter in an automobile, which separates grit from the oil.

Any device or circuit which separates signals into two or more groups can be rightfully called a filter. Since a filter is anything which does this job, we must have various categories into which to classify filters.

One major classification method is to divide filters into *active* and *passive* filters. Active filters are circuits which make use of amplifiers as a part of the filter itself. They are relatively recent developments and are seldom encountered in ham radio; about the only devices used by amateurs which may be termed active filters are the Q-multiplier and the select-o-ject circuit. For now, we won't pursue active filters further.

Passive filters are circuits which do not contain amplifiers within the filter circuit. Most filters are of the passive sort, and throughout this installment when we use the term filter we will be speaking of the passive type.

Another way to classify filters is by the type of action they perform (Fig. 4). All

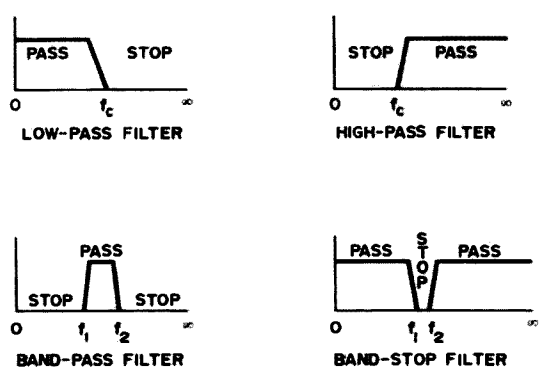


Fig. 4. Idealized frequency-response charts illustrate principal characteristics of low-pass, high-pass, band-pass, and band-stop filters. Each separates applied input signals into groups which are either passed or stopped. Frequencies which mark boundaries between these bands are known as cutoff frequencies.

filters separate signals into two or more groups, but they do so in different manners. This classification scheme puts any filter into one of four groups – low-pass, high-pass, band-pass, and band-stop.

The separation action of a filter can be described as letting one group of signals (passband) go through, and blocking all

other signals (rejection band or stop band). The frequencies at which the passband and the rejection band meet are known as cutoff frequencies.

A low-pass filter passes all signals below its cutoff frequency and rejects those above; that is, its passband goes from 0 Hz up to cutoff, and its stop band goes from cutoff on to infinitely high frequency.

A high-pass filter rejects all signals below cutoff, and passes all those above. Its stop band corresponds to the low-pass unit's passband, and vice versa.

A band-pass filter has one passband and two stop bands. The first stop band runs from zero frequency up to the lower cutoff frequency, and the second stop band runs from the upper cutoff frequency to infinity. The passband is the region between lower and upper cutoff frequencies. A resonant circuit, by virtue of its selectivity, is a band-pass filter.

A band-stop filter is the opposite of a band-pass filter; it has two passbands and one stop band, and passes all signals except those between its lower and upper cutoff frequency.

In practice, the band-stop filter is rarely encountered. Power supply filters are excellent examples of low-pass filters with cutoff frequency lower than the ac power line frequency, so as to leave only dc in the output. Tuned circuits are examples of band-pass filters. The kind of TVI filter which is connected to the TV receiver (rather than to the transmitter) is a high-pass filter.

Performance is not the only classification criterion, however. Filters may also be grouped according to the techniques used in their design. This involves two major techniques, each of which has a number of subcategories.

The major design techniques are known as "image impedance design" and "modern network theory" methods. Most filters in the past 50 years have been designed using image impedance methods, although this technique requires the use of physically impossible components and so cannot produce accurate results. Within the last decade or so, the modern network theory method has been brought to prominence to provide more accurate filter action.

Filters designed by image impedance techniques fall into two subcategories, known as *constant-k* and *m-derived*. Both these labels are just names, and bear no relation to the performance characteristics of the filter. The *k* and *m* refer to mathematical variables used in the design equations.

Filters designed by modern network theory methods bear names associated with the mathematicians who studied the various types of equations involved in the theory. The most widely known of these filter types is the *Tchebychev*. Less well known is the *Butterworth* design.

Classification by design method is not rigid, because many of the design techniques overlap. It's quite possible to encounter an m-derived Tchebychev filter, and the entire image-impedance technique is actually a special case of the Butterworth design area, although it's not usually so labeled.

To complicate the question a little more, filters always include both series and parallel components, at least one of which (and often both) is reactive. This means that the most primitive building block possible in a filter is the combination of one series element and one parallel element. Such a circuit (Fig. 5) is known as a half-section.

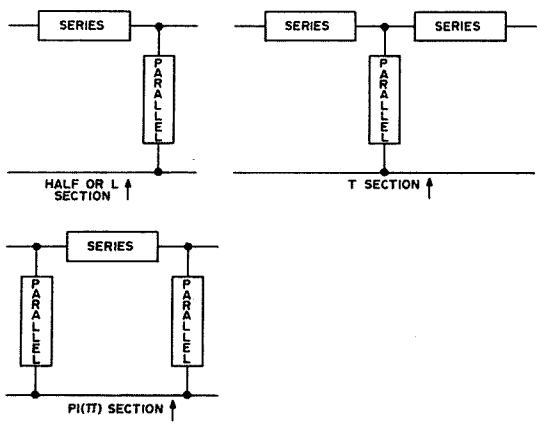


Fig. 5. Different arrangements of components in filter circuits bear names suggested by resemblances to various letters of alphabet. Pi-section resembles no letter in our own alphabet, but is dead ringer for π of Greek alphabet. Elements represented by boxes here may be resistors, capacitors, inductors, or combinations of any or all of these.

Half-sections can be connected together so that the two series elements meet, or so that the parallel elements meet. In either case, the two elements which meet can be combined into a single element; the resulting three-element circuit is known as a section. If it has two series elements but only one in parallel, it's called a T-section (from its resemblance to the letter). If there's only one series element and two in parallel, it's a pi section, from the resemblance to the Greek letter π. And if we don't combine at all but use only a half-section, it's sometimes called an L-section.

That's not all the possibilities, but we have enough on hand for the moment.

The functional description – high-pass, low-pass, band-pass – is most generally used, unless it's necessary to be more explicit about the particular filter circuit involved. Even then, the functional description is usually retained, and the added classification simply tacked onto it, to give us a "low-pass constant-k filter using π-sections" or a "high-pass m-derived filter using T-sections."

A final classification – "balanced" and "unbalanced" – must wait until we examine the details of filter operation for its discussion. Let's move right on.

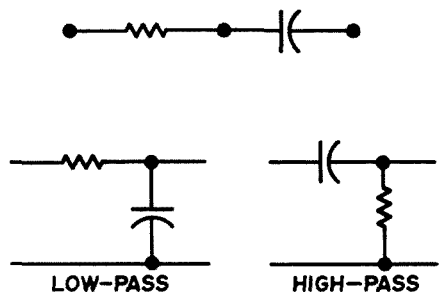


Fig. 6. Simplest filter circuit consists of one resistor and one capacitor in series, as shown at top. This forms an RC L-section, which may be used for either low-pass or high-pass purposes as shown in the two lower schematics. Method by which filter operates is explained in text; all filters work on this basic principle, but more complicated circuits modify it in various ways because they contain not just one but several reactances, each of which behaves differently.

How Do Filters Operate?

We have just seen that filters act to separate signals into groups by permitting signals in the passband to go through, and rejecting signals in the stop band(s). How is this accomplished?

The clue is hidden in our statement that every half-section of any filter contains at least one and often two reactances. A reactance is frequency-sensitive. That is, its characteristics depend upon signal frequency. By combining reactances of proper types and values, we can get almost any kind of filtering action we may desire.

To show how this works, let's begin with the simplest possible filter arrangement (Fig. 6) containing only a single half-section and a single reactance. We already looked at this circuit, but not in this context. It contains a resistor and a capacitor, with input applied across both and output taken across only one.

This circuit can act as either a low-pass filter or as a high-pass unit, depending upon which element the output signal is taken across. To see how this works, let's assume that the resistor's value is 1 kΩ, and that the capacitor's reactance is 1 kΩ at a frequency of 1 kHz.

For an input signal of 10V at 1 kHz, then, since resistance and reactance are equal at this frequency, we will get the same voltage across either the resistance or the reactance. Because of phase shifting, we will actually find 7V across either; we went into the reasons for this before. With 10V input and 7V output, we have 3 dB loss.

If signal frequency goes up to 2 kHz, the resistance will not change but the reactance will decrease to 500Ω. We now have less voltage developed across the capacitor than across the resistor. As signal frequency is increased still more, the reactance keeps going down; when we reach a signal frequency of 10 kHz, the reactance is only 100Ω, and at 100 kHz the reactance is down to 100Ω. Resistance remains unchanged, so that the voltage division between resistor and capacitor reduces capacitor voltage and leaves most of the voltage across the resistor.

If our output voltage is taken across the capacitor, we have a low-pass filter. As signal frequency goes up, output voltage goes down. If, on the other hand, we take the output from the resistor, our filter is a high-pass unit, as output voltage increases with frequency.

At dc or "zero frequency," all the input voltage appears across the capacitor. At the frequency at which resistance and reactance are equal, 70% of the voltage (half the power) appears across the capacitor. At infinite frequency (a purely theoretical idea, granted) no voltage at all appears across the capacitor. In between, whenever signal frequency is doubled, the output voltage drops to half what it was before, because the reactance drops to half its previous value.

This somewhat idealized description leads to the idea of a "6 dB per octave" cutoff rate. Cutting voltage in half is introducing a 6 dB loss, and doubling the frequency is equal to going up an octave in the musical scale. The theoretical limit of the effect of a single reactance is 6 dB per octave.

An actual RC filter like the one we've been examining does not reach this rate in practice. Its cutoff frequency is defined as being the frequency at which X and R are equal (1000 Hz in our example) and in that region the slope is only 3 dB per octave.

We can improve its performance in several ways. One is to cascade additional half-sections. This modifies its action in many ways, since the first reactance now has another half-section in parallel with it and no longer behaves as a pure reactance. Another (Fig. 7) is to replace the resistor

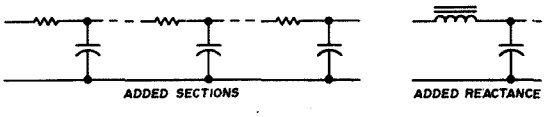


Fig. 7. When performance of simple filter of Fig. 6 is not adequate, either or both of two routes may be taken to improve it. Sections may be added (left) or additional reactances may be included (right). Usual filters encountered in practice do both; design technique is rather complicated but results justify it.

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with an inductor, thus putting two reactances in rather than one.

When we do either of these things, we immediately find ourselves involved in the intricacies of filter design. With both inductive and capacitive reactance in the circuit, we have the certainty of resonance at *some* frequency, and this may or may not be good for our purposes. This is not the place to delve deeply into filter design theory; all we can do is skim the surface enough so that we are able to identify the various parts of any kind of filter.

The constant-k filter design procedure amounts to a method for replacing the resistor with an inductor, together with adding additional half-sections, to produce a filter with the desired cutoff frequency and cutoff rate. The resulting filter's input and output impedances will vary in a definite manner which the designer cannot control, so that this type of filter can be used only when its impedance characteristics are satisfactory for the purpose. A typical power-supply filter amounts to a constant-k low-pass filter; the "choke-input" filter uses a T-section followed by an L-section (with two of the three inductors combined into one so that it appears to be two L-sections), and the "capacitor-input" filter is a π-section standing alone.

The m-derived filter design procedure offers the designer another level of control. He can achieve the cutoff frequency and rate desired, just as in the constant-k procedure, and in addition he has the option of controlling either the impedances or the attenuation characteristics (but not both). To do this, a part of the circuit resulting from the constant-k design is converted into a resonant circuit. The ratio between cutoff frequency and the resonant frequency of this converted portion yields the variable named m, which gives the procedure its label.

The distinction between a constant-k filter and an m-derived filter (Fig. 8) is simply the presence of a resonant circuit where one would expect to find only a single reactance. If such a circuit is present, the filter is m-derived.

Filters designed according to modern network theory techniques may look the same as either type of image-impedance circuit. In these designs, the engineer trades off the ability to control certain characteristics in order to gain control over others. The most popular Tchebychev designs, for example, permit some degree of ripple (uneven response) in the passband to achieve a cutoff rate greater than the theoretical 6 dB/octave/reactance limit for image-impedance designs.

These trades are made by designing each separate section of the filter for a different cutoff frequency; the complex math involved in the design procedure specifies the particular cutoff frequencies to be used.

Regardless of the design procedure, a filter may be built to operate in either a balanced or an unbalanced condition. These terms are not limited to filters – they apply to all signal transmission circuits, and affect filters only because filters are used in signal circuits.

The most conventional practice for any kind of signal transmission is to ground one side of the transmission path, and then work a hot line against ground throughout

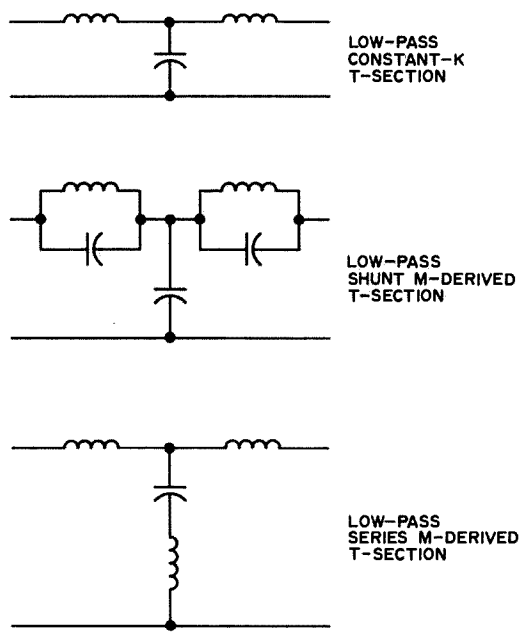
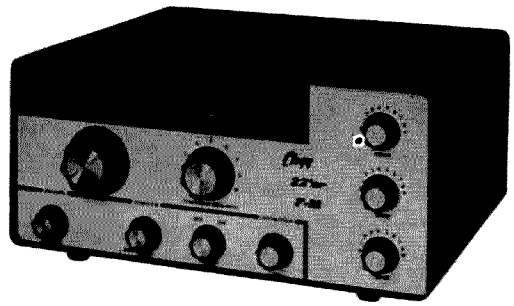


Fig. 8. Differences between "constant-k" and "m-derived" filters are apparent when the schematic diagrams are examined. Any "m-derived" filter contains resonant circuits replacing simple reactances. "Series" and "shunt" portions of names refer to type of resonant circuit, either series-resonant or parallel (shunt).

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the resulting system. This is unbalanced operation.

It's equally feasible to keep both sides of the path separate from ground. If the circuit is arranged so that both sides of the path are separate from ground, but so that one is always above ground level when the other is below and vice versa, the circuit is said to be balanced. A push-pull amplifier is a good example of a "balanced" circuit. So is the industrial circuit known as a "differential" amplifier, in which the signal is the *difference* between the individual signals on each input line.

In an unbalanced circuit, any accidental stray coupling between circuits cannot be readily corrected since there is no way to distinguish between desired and undesired signals. Most of the undesired signals are inherently unbalanced in nature.

The balanced circuit permits such a distinction, because it is possible to reject any unbalanced signals appearing in a balanced path. Commercial telephone circuits are all balanced for precisely this reason; it permits the reduction of crosstalk to acceptable levels.

A filter for use in an unbalanced line must be itself unbalanced. The sample circuits we've been examining are all unbalanced; the series element appears in only one side of the filter, and the input and output terminals have a common or ground reference.

To convert such a circuit to a balanced filter for use in a balanced line, the series elements are divided between the two signal paths (Fig. 9). Then half of each series element appears in each side of the line. The total series impedance is unaffected by this change, but there is no longer a common terminal between input and output.

What Is Amplification?

In all the circuits we've looked at so far, we have had only one generator or power source and all the rest of the circuit has been composed of passive components that dissipate energy or convert it from one

form to another, but which have not added any additional energy.

In practice, radio deals with extremely small amounts of energy. It's necessary to boost the energy levels while retaining the

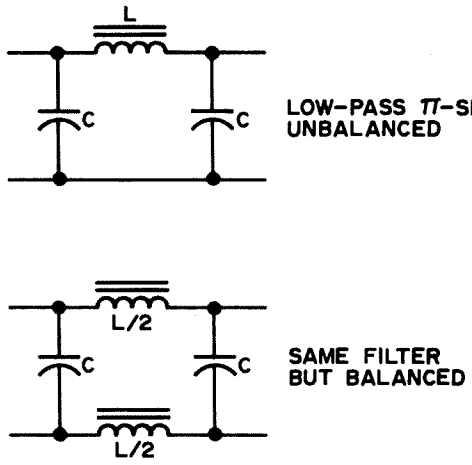


Fig. 9. Most conventional circuits are unbalanced in nature, as at top, with both input and output circuits sharing a single common ground line. If balanced circuit (bottom) is in use, input and output circuits have no terminals in common. Any design may be converted from unbalanced to balanced operation by splitting series elements between the two signal lines.

major characteristics of the original energy. Any device which does this job is known as an amplifier.

This definition of "amplifier" is intended to make it plain that every amplifier provides a source of new or added energy to a circuit. In addition, it must control this added energy in such a way as to make it conform to the desired (or major) characteristics of the original energy in every way except strength.

An amplifier, then, is a device for adding energy while controlling its characteristics – and amplification is the process of doing this.

One way of adding energy is to introduce a generator into the circuit. Another way is to add a battery. Unfortunately, while the energy from a battery is plentiful enough, it's difficult to control.

However, we have been making much use of the voltage-division capability of series circuits composed of resistors. If we have two resistors in series with our battery, one of them fixed in value and the other variable, we can control the added energy by varying the resistance of the variable resistor.

We now have the basics of a rudimentary amplifier – a source of energy to be added, and a means for controlling the energy. It may come as no surprise to find that almost all practical amplifiers boil down to this simple basis – a battery and a variable resistor. (See Fig. 10.)

The variable resistor, though, seldom looks much like what you would expect. Conventional variable resistors achieve their variations by mechanical means, and cannot exert control rapidly enough to follow all the gyrations of an ac signal. The variable resistors we find in practical amplifiers to control the added energy achieve their variations by *electronic* means rather than mechanical. We call them vacuum tubes and transistors.

We'll examine the actual methods by which vacuum tubes and transistors achieve variable resistance later; each does it differently. The important point at this stage is that so far as the electrical circuit itself is concerned, they do act as variable resistances, whose resistance depends in some way upon the input signal. The British term for the vacuum tube – valve – is highly descriptive of the function. A small input signal controls the resistance which the tube offers in the energy-adding circuit, and thus produces an output signal which matches the input in every desired way.

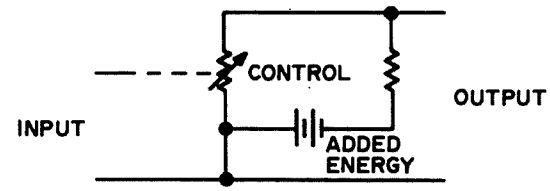


Fig. 10. Basic amplifier circuit consists of source of added energy and variable resistances controlled by input signal which together permit input signal to control amount of energy added. Schematic diagram shows the principle involved, but no real amplifier looks much like this. Control function is usually provided by either transistor or vacuum tube, which is acting as electronically variable resistance.

By proper circuit design, we can make the output signal's characteristics match all of those of the input signal, or we can select only a few features of the input signal and eliminate the rest from the output. The ability to do this makes it possible for us to modify signals in just about any way we like – for instance, we can preserve the frequency characteristic while eliminating any changes in strength, and this is what makes FM so much more free of atmospheric noise than AM. We can preserve the variations in strength while changing the frequency, and this makes today's sensitive receivers possible by permitting the "superhet" receiver design. Or we can preserve all the original characteristics, boosting only the strength, and we have full fidelity sound systems. All of this depends upon the control inherent in the amplification process.

How Do Transistors Amplify?

At the moment, we're interested primarily in transistors and how they amplify. We'll wait until later to approach vacuum tubes, which operate rather differently although they do the same basic things.

The name transistor itself comes from a blend of *transfer* and *resistor*; before the transistor, few persons thought of amplification in terms of variable resistances and steady energy sources. Instead, they thought in terms of imaginary "generators" of ac inside the amplifier – and many of today's engineering textbooks adhere to this concept.

But the transistor has nothing in it which even remotely resembles a generator, and it does its job precisely by controlling series resistance, so the "steady energy source/variable resistance control" is a direct picture of how transistors operate.

A transistor consists of three distinct regions of semiconductor material joined into a single crystal. It's something like a sandwich, except that the "junction" regions which separate the different types of material are actually part of a single continuous structure. The two outer regions are of the same type of material, and the inner part is of the opposite type.

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The semiconductor materials used are primarily either silicon or germanium. Both these are metallic elements, and both of them, in an absolutely pure state, are rather good insulators. If very small amounts of specific kinds of impurities are added, however, they become rather good conductors. One kind of impurity (donor) puts an excess of electrons into the crystal structure, while the other kind (acceptor) doesn't have quite enough electrons and so produces "holes" where electrons can rest but cannot quite fit permanently.

Semiconductor material containing donor impurities is called N-type material, and that containing acceptors is known as P-type.

A transistor, then, consists of either two regions of P-type material separated by a region of N-type, or of two regions of N-type separated by P-type. The first is called PNP, and the second NPN. Since they are mirror images of each other, we'll look only at the operation of an NPN transistor. To apply this to a PNP unit, simply reverse all the polarities involved.

Before we get inside a transistor, though, let's see what happens at a single junction (Fig. 11). Such a junction, P-type on one side and N-type on the other, is widely used; we call it a diode.

If we connect a diode into a dc circuit with the P-type material connected to the positive side of the power source and the

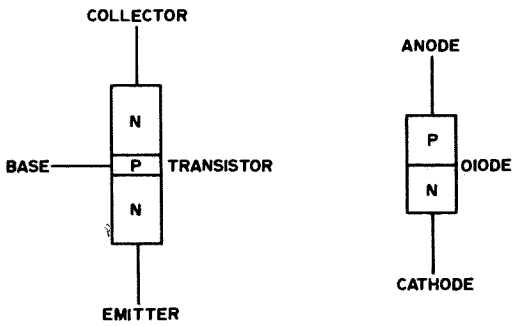


Fig. 11. Transistors and diodes consist of slabs of semiconductor material formed into a single structure. Differences in atomic characteristics between crystal in N-type region and that in P-type region provide required control actions.

N-type to the negative side, then we find that the excess of electrons at the negative side of the power source meets a similar excess of electrons in the N-type material, and the resulting repulsion between electrons must be overcome before any current can flow. The resistance is rather high.

If we reverse polarity of the connections, then the excess of electrons at the negative side of the power source find room to move into the "holes" of the P-type material, displacing the excess electrons from the N-type material across the junction and sending them on to fill the shortage of electrons at the positive side of the power source. Current flows readily. The resistance is low.

The diode, then, has low resistance for current flow in one direction, and high resistance to current flow of the opposite polarity.

When we add a second junction to put the third region into our device and change it from a diode into a transistor, each junction still retains this one-way characteristic. However, events at the two separate junctions interact with each other.

We call one of the outer regions the emitter, the other outer region the collector, and the inner region the base. The junctions are known as the base–emitter junction, and the base–collector junction. In practice, we apply the input signal into a circuit which includes the base–emitter junction, and it controls the resistance of the base–collector junction. Fig. 12 shows the arrangement.

The interaction between junctions is such that the base–emitter junction must be operating in its low-resistance condition (forward biased), and the base–collector junction in its high-resistance condition (reverse biased) for the control to occur.

In essence, what goes on is this: Some of the electrons moving in the base region as a part of the base–emitter current escape from the base by way of the base–collector junction, instead of through the base–emitter junction. In the base–collector junction, these "injected" electrons are going the wrong way on a one-way street. That is, they are going in the opposite direction, and so tend to *reduce* the amount of reverse bias maintained on the junction. This reduction of reverse bias amounts to a decrease of resistance.

If only a small portion of the electrons injected into the base–emitter circuit escaped into the collector circuit, the effects would be correspondingly small. However, the geometry of the regions is such that *most* of the current in the emitter region goes on through the base into the collector. Only a small fraction of

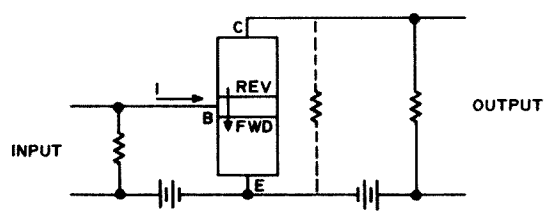


Fig. 12. Current flow through base–emitter circuit controls that in collector–base circuit by interaction in base region. Shown here is common–emitter circuit arrangement.

the emitter current appears in the base circuit. The result is that the effects are correspondingly large. A current of only a few millionths of an ampere in the base–emitter circuit controls currents thousands of times larger in the collector circuit, and we have amplification.

Something similar goes on in tubes, but the control action is different. In a tube, electrons boil off of the cathode and travel to the plate, passing the grid in the process. The voltage level on the grid controls the number of electrons which get through, and so controls the plate current.

That is, the cathode in a tube corresponds to the emitter of a transistor, the grid corresponds to the base, and the collector to the plate.

The major factor used to rate transistors for "gain" currently is a ratio known as *beta*. A transistor's beta is the ratio between base current and collector current; if a specific transistor will permit a collector current of 50 mA to flow with a base current of 1 mA, it has a beta of 50/1 or 50.

The beta of an individual transistor depends upon many factors. The voltage applied to the collector is one such factor. Another is operating temperature (the hotter the unit, the less control the base current has over collector current). In general, however, beta depends primarily upon the internal design of the transistor, and remains relatively constant. Modern transistors range in beta from around 10 to over 500.

Neither transistors nor tubes are all-purpose amplifiers. Each has its own area of application, but the two areas overlap rather widely.

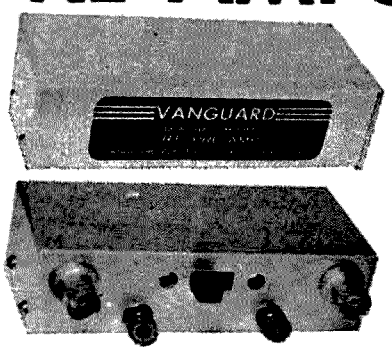
Transistors are used in almost all commercial audio amplifiers; they are also used as rf amplifiers at lower power levels. (High power, high frequency transistors exist, but they are expensive.)

This examination of transistor action and how it compares with that of tubes has of necessity been kept brief; you can find more details in our previous study courses for the Advanced and the Extra license examinations. While we have included here enough to meet the current General study list, it's likely that as time passes the General examination also will concentrate more and more upon transistors and less and less on vacuum tubes. When that happens, the additional information will probably be necessary – so if you can, do some additional studying about transistors. It may not be needed to get your ticket, but it will definitely help you understand the equipment you'll be using afterwards!

. . . Staff ■

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depend upon it, but who are now unable to make full use of it. It would bring hundreds of thousands of nonhams to a logical "jumping-off" place from which to advance themselves into our ranks, thus promoting a healthy growth for the hobby. This would provide us with a source of raw ham material for many years to come, and we could certainly use more hams, if we are to continue growing. The band which has been proposed is not widely used; consequently, its restructuring would not impose any inordinate hardship on its present users to any great extent.

For these reasons I have come to the conclusion, and I think that many others will too, that this proposal is a good one, and should be adopted in the near future.

Technicians

All right: granted... I have been belaboring the question of Technicians and the proposed allocation of additional frequencies sufficient unto the gravity thereof. And surely, by this time all who have been alerted and alarmed by the sounding of the tocsin will have made their opinions known to the ARRL directors, the FCC, all their friends and colleagues on the air, and anyone else who would listen, and thereby be convinced. I have nothing to add to my fundamental objections. But there are some afterthoughts which, while not speaking directly to the question per se, do bear upon it somewhat.

Any casual survey of the equipment market, both new and used, will disclose that there are very few transmitters or transceivers which are limited to 10 meters alone. Almost every piece of gear on the market includes the other so-called "low bands." Presumably, the Techs, if and when the new allocation becomes a reality, would acquire equipment that would cover not only the segment granted, but all five bands. And on thousands of shack desks, from coast to coast, constituting an ever-present Lorelei, will be sitting, as big as life, a shiny new Whatziss Mark Four, with a couple of hundred watts PEP under the hood, just rarin' to go. Hopefully, most of the fellows will resist the temptation successfully.

Now, I beg of you...don't get me wrong. All you Techs who have absolutely no eyes to exceed your frequency allotment...that is not what this piece is all about. I am not interested in condemning anybody before the fact. I would not dream of indicting anyone of "conspiring to advocate the overthrow of the FCC regulations by force or violence," and so I hope that I will not be smothered in a deluge of angry denunciations, and I trust that 73 will not be on the receiving end of any premature and precipitate cancellations of subscriptions. Please have the patience and forbearance to hear me out before you bite your pipe stem in two.

I state now, without any qualifications whatsoever, that I am certain that the overwhelming preponderance of the Tech group, if granted the ten meter segment, will use it precisely in the manner prescribed, and will not make any excursions into portions restricted to them. If there do happen to be any violations, well, they will most probably occur to no greater extent than they do right now, and which originate among all classes from Extra right on down the line. The proportion of law breakers and miscreants holds pretty consistently, no matter what stratum of society (or hamdom). People are people!

Idle curiosity prompts me to ask how the FCC proposes to monitor all the frequencies to see that the occasional "poacher" will be detected. It is surely unrealistic to imagine that an agency with severe shortages of funding and an insufficiency of manpower, which is having trouble policing the presently constituted bands, could suddenly develop the additional capacity to do so under that added workload which is bound to ensue with any change.

I am a devout believer in the honor system. I have seen it work in many fields. Because I hold affirmative views with respect to the inherent honesty and integrity of the individual, I feel confident that we hams are completely capable of policing our own bands for ourselves. And since FCC could not begin to do an adequate job in this connection, it is absolutely imperative that we all feel a sense of urgency toward this problem. It is important that every ham who participates seriously in this hobby makes it his personal business to continue to be vigilant in protecting our bands from deviations from the regulations, by Techs, or *anyone else*.

If we fail to do this, it is possible that the entire image of ham radio will suffer irreparable damage, to the ultimate detriment of our privileges. We must not allow the existence of any condition to which outsiders may point, in their constant efforts to preempt or commandeer our frequencies.

I am not advocating an era of tattletale activity in amateur radio. This would engender an atmosphere of distrust and fear which might be worse than the situation it sought to remedy. But conscientious amateurs are urged to bring their influence to bear upon their associates and friends, in a determined effort to try to prevent wholesale frequency violations. There is sufficient evidence to indicate that only a negligible minority attempts to flout the rules. But we know from recent political history just how much damage a small minority can cause if its activities are not detected and circumvented.

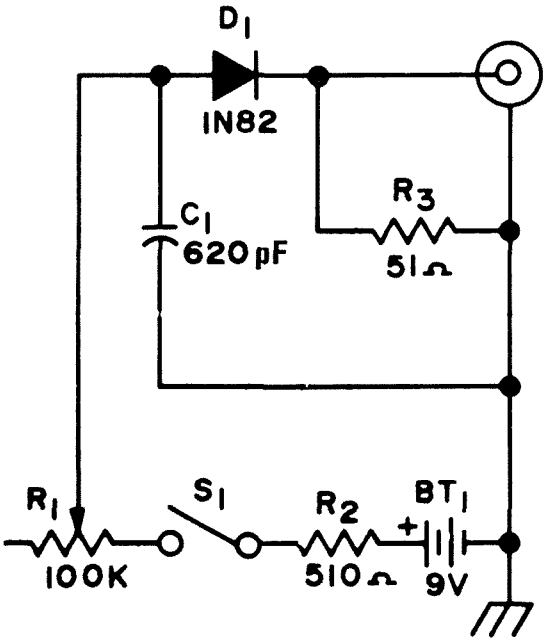
Using Ten for CW

While discussing this matter of the possible change of 10 meter allocations, I have another idea to advance. While it is certain that most of the operators will be utilizing their new segment for phone operation, I should like to remind you and emphasize that operations will not be limited to this mode. The proposal calls for "...voice (or other) emission." There is a golden opportunity here, which for the first time makes it possible for Techs to obtain actual on-the-air experience toward genuine upgrading. There has been no marked attraction for Techs in the practice of MCW on 2 and 6 meters. This poor substitute for CW never approached a status of universal acceptance among them. And this deficiency of means is one of the important reasons why Techs have always had trouble with the code. Now, however, there will be a very convenient avenue through which this discriminatory deficiency may be offset...through which the obstacle may be attacked and overcome. It is to be hoped that many Techs, not content merely with the gain of a small phone segment,

A $1.40 NOISE GENERATOR

There are probably many hams who have at one time or another built a receiver or converter. And probably many of these devices have a less-than-enviable noise figure. With a noise generator, one can work on reducing inherent noise. The noise generator described here is not the best that can be built, but it is probably the least costly thing around in these days of inflation.

The components for this device cost about $1.40. (I scrounged the hardware.) The diode is a 1N82, although almost any UHF or microwave diode could be used.



The 51Ω resistor is approximately equal to the receiver input impedance. It will take about 10 minutes to wire this up. Have fun with the noise!

Stephan Goldstein ■

Leaky Lines *(cont. from p. 96)*

will rise to the challenge, at last, and use the band for CW, in order, finally, to go for the General ticket, and negotiate the exam successfully.

If you agree with this premise, and I hardly see how you can fail to, why not devote a portion of your schedule to regular operation on the segment, for the purpose of assisting Techs in their quest for CW proficience. We can be of great help if we extend the same traditional cooperation we have always given to the Novices on their CW segments.

If we fail in this we may foster twin evils. First: we might simply isolate the Techs into just one more "solitary confinement" situation. Second: we will be neglecting an opportunity to promote the growth of amateur radio through advancement. Let's make sure that not a single Technician who expresses a desire to build his speed and CW savvy fails to find a willing hand among us.

This is a two-way street. We can learn much more from some of the Techs than many of us are willing to admit. They have become specialists and experts in the fields of VHF, ATV, RTTY, FM, and UHF, and remote control. Their participation in the fields of amateur satellites and moonbounce are worthy of recognition and praise. The percentage of Technicians who design and build their own gear is far larger than anything we could match.

The anticipated revision of the amateur spectrum, while it does incorporate some dangers and disadvantages about which I have previously written, possesses some very positive values also. It will present an opportunity for vital interchange and meaningful development in ham radio. Ideally, we will make the most of this chance.

73. . .K2AGZ■

Mr. Virgo Himself *(cont. from p. 14)*

> purchasers. If we had shared this concern we would not have introduced the 1011.
>
> However, despite our conviction that the 1011 is a useful addition to the Swan line, we have decided to defer to our critics and curtail future production of this unit.
>
> Since we have completed one production run of the 1011 we can fill most orders from our dealers promptly, but because of the existing controversy we will not solicit additional orders for this unit.

Well, how about it, fellows? Are we going to leave Swan with this stigma or are we going to outvote the lunatic fringe? Please – for ourselves – write Swan and ask that the Model 1011 not be canceled. That piece of equipment is sound in design and workmanship and it can ideally perform the functions for which it has been engineered. Can we really expect more?

. . . K6MVH ■

(W2NSD cont. from page 10)

This book is so important that I have made arrangements for our Radio Bookshop to handle it. This book should be in every ham's car and handy for every ham's wife too. I just don't see how it is possible to ever lose a traffic ticket case when you have this book in hand.

Do you know what to say and what *not* to say when the traffic cop hands you a ticket? Send $2 today to Radio Bookshop, Peterborough, N. H. 03458 for a copy of this invaluable book. This book can save you future fines, loss of license and a lot of headaches.

King Hussein

As this is being written the Syrians are invading Jordan, the Iraqi troops are poised in Jordan, threatening to support the commandos against the government troops, Amman is in flames and things are generally in an awful mess.

Right in the midst of the furor His Majesty made news all over the world by turning to his ham rig and relaxing with a few contacts. He called Mary WA3HUP, who visited him shortly after I left Amman in May and just before the first serious battle between the government and the commandos in June. He also talked with a few hams in the midwest and talked a bit about the situation in Amman.

CBS news (and others) were on the phone immediately, pressuring Mary to try and contact His Majesty for an interview. Mary, figuring that if the king wanted an interview he would ask for it, declined. They called me to see if I could help them. I agreed to ask if the opportunity arose, but pointed out that I had no intention of putting pressure on him because I was afraid that he might do it for me rather than because he wanted to do it.

It was with relief that I did not hear His Majesty on the bands for the next couple of days. I wanted to help CBS if I could, but I didn't want to create any problems for the king.

There is no way to describe my feelings as I read the papers day by day, following the terrible situation in Jordan. The hotel where I stayed four months ago was being shelled. Commando snipers were shooting at anyone seen peeking out of the windows. Fire and smoke lay in clouds over the city. The commandos held a roadblock at a circle where I had walked and taken pictures a few weeks before. Hummar, the lovely summer palace where His Majesty has his ham station, was shelled by the commandos.

How had the Arab-Israeli situation come to this? Who was to blame? Those of you who have read the Quaker booklet (available from 73 for $1.00) know that there are no angels and no devils, just an unfortunate and really quite logical course of history. A good deal could have been done to keep the situation from getting as bad as it has, to be sure. The booklet points out the best courses of action, all things considered, and with no sides taken.

Naturally I feel empathy for King Hussein and the people who were so nice to me in Jordan. I also feel a great sadness at the loss to the commandos – they feel that they are doing what is best for Palestine and their future. And I respect the Israelis who have done such a tremendous job of building up their little piece of desert into a modern thriving country. I agonize over their impossible decisions as well as I do over the Arabs who demand that the impossible decisions be made. Though I have visited Syria and Iraq and was treated graciously in those countries, it is difficult for me to feel any sympathy for their invasion of Jordan.

With no possible good solution to the worsening situation in sight, we go to press. If any readers do contact His Majesty on the air please give him my best regards and, I hope, the warmest feelings of brotherhood from all amateurs in his time of greatest trial.

Three New Ones

While I am by no means near the top of the DX hierarchy, I have worked enough countries so that a new one is rather hard to come by. Thus it was quite a surprise to me the other day when I managed to snag three new ones all in one evening.

It started off easily. I was heading for the kitchen when the thought struck me that I should check the band, just in case. I didn't know in case of what. The only DX that had been scheduled to show was Frank DL7FT who was reported on his way back to Berlin after an unsuccessful attempt to get on the air from Albania. I tuned twenty meters and there it was – a pileup! I tried to hear who they were calling, but everyone was just giving his own call. Finally one chap let it out of the bag by standing by for Frank. Hmmm, he must have made it after all. The fellows calling him were spread out over the bottom part of the band so I knew Frank must be out of the band. Sure enough, there he was down about 14,192 or so, giving out reports as fast as he could. I checked for a relatively lightly used frequency and gave him a quick call. "The portable one, come again." I'd done it! We exchanged reports and calls and I had a new one.

A couple of days earlier I had gone over to visit editor Ken to try out a beautiful little FM rig that had just arrived from Regency. After giving it a workout we got going on a game of chess and it was 2:30 before I threw the game to Ken in desperation so I could get away. Being a better than average player he probably would have won anyway, so it was no sacrifice. I got back home well ready for bed . . .hmmm, better check the band.

It didn't take long to hear ZK1MA working a list supplied by a W6. I listened for a bit and heard it come to an end. Then fellows started calling in to get on the list for two days later. I entered my call on the list.

Sure enough, right on schedule, not too long after my ZA2RPS contact, list time arrived and I called as my call came up. Nice report from Manihiki and another one in the bag. He gets on

for about an hour a day with his battery powered rig and works a list for the hour. He then spends a day recharging the battery for the next bout. Without the list very few fellows would ever get the country, even so you will probably not be surprised to know that some chaps get on there and intentionally interfere.

After the ZK I tuned up the band and heard a beautiful signal signing off after a short contact. It was too loud to be anyone of great rarity, surely. Wrong. It was VR6TC on Pitcairn Island. When Tom signed and asked for calls the whole band seemed to answer him. I called him a couple times . . .twice more . . .twice more . . .nothing. No answer to anyone. I broke in and talked to a friend for a moment who was coming through on backscatter from New York, then stood by for Tom, just in hopes. And there was Tom coming back to me! It was probably four or five minutes after he had started listening and everyone else had long ago given up and started looking for him up or down the band, figuring that the pileup had discouraged him.

That was a very satisfying evening.

$50 Reward!

Frankly I would like to have some gorgeous girls on the cover of 73 – and it isn't as if we don't have a good supply of 'em in or near the ham ranks. You photographers out there, get your lovely wives, daughters, mistresses, or even neighbors into the shack, up on your tower, or somewhere that will make a good picture for our cover. If the fems have a call, so much the better and extra points from our picture editor. Send in some glossy 8 x 10s. Let your imagination run wild, please. Shoot black and white until our advertising picks up to the point where we can run color covers again.

You can't think of any ideas for pictures? Good grief! Maybe she is helping you put up a beam, a tower, or bringing your dinner to the operating desk while you are in a contest. Perhaps she is just building a kit. Maybe she is operating and you are bringing the supper tray. She might be looking very perplexed at a study manual . . .etc. You can do better than any of those ideas, surely.

Think PR

The Dave Bell Ham's Wide World film is great for us, but it can't carry the entire load of promoting amateur radio forever. Most television stations will show it once and that is it. We do need follow up programs to keep amateur radio in mind as a good thing when those same television viewers start getting interference or see a particularly big beam sprouting in their neighborhood.

The normal ragchew contact does not have much grist for the PR grill, admittedly, but then all of amateur radio is not trivia . . .just most of it.

What can you do to help promote amateur radio? You can keep your ears open for PR possibilities. Then, when they occur, you can arrange for the news to get out.

For instance, suppose you have a friend who is talking of a DXpedition to an island somewhere. If he goes to the island, works a thousand or two amateurs and then comes home, the news will hit the ham magazines and that is about all. Big deal! But if he lines up a partner for the trip with a reasonably good movie camera and some experience with it, he can end up with a documentary film of the Dxpedition that will be of interest to dozens or even hundreds of television stations, radio clubs all over the world, and might even pay for itself.

Perhaps you have a friend interested in moonbounce work. Great PR here! Again arrange for a documentary film of the fellow or fellows who set it up, the operation, and pictures of the fellows on the other end of the bounce. You can put in some shots of the moon, the world, and such to explain what is happening. Aerial shots of the layout at VK3ATN would be wonderful for a film on this subject. And shots of the big dish at Arecibo would be interesting too.

Even a short documentary of a local ham building a piece of equipment would fit in the picture. Plan ahead on this and show the unit in its various stages of being built and tested. Other local hams can get in the act, helping with the work or the testing.

Fox hunts can make wonderful movies. Start with a shot of the committee planning the hiding place, then show the rig being hidden. Finally off go the hunters and hidden cameras can record their wanderings. A good director will enact the whole thing rather than doing it from life. This way you can set up for some great shots such as the hunter passing the fox rig and the loop antenna suddenly spinning around. Don't forget close-ups of the gear used for hunting down the fox plus smiling winner pictures.

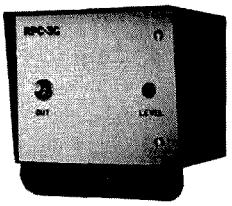
A repeater group could turn out an interesting film showing their operation, complete with handi-talkies, mobile units, base stations, control units, maps, the works. While this might not be of as much interest to TV stations, it would be wanted by clubs and would fit in a TV series if enough individual amateurs turn out ham films.

Any special club efforts are worth filming, whether it be Field Day or phone patches for a local army hospital.

If film is too much for you to manage, then at least think in terms of slide shows with tape cassettes that can be used by clubs. Most clubs of any size have at least one film nut, complete with, hopefully, a 16 mm camera. Few amateurs have sound film systems yet, but they are coming, either via sound on film or video tape. Even super-8 is better than nothing. Let's get the effort started now and work toward more professional results later.

Lastly: please let me know what you are doing so I can help spread the word to encourage others. And if you need any help in locating TV stations or clubs that would like to see your films just write and then wait for me to eke out an answer. 73. . .Wayne ■

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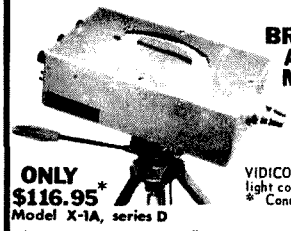
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LETTERS

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ou goons don't ever proofr
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should be boiled in oil ov

That "Fringe"

You fool very few readers with your sly way of trying to subvert the minds of your readers with an attempt to dismiss lightly the role your pal Hussein plays in the Mideast.

His country is used as a haven for terrorists with his permission.

His country is governed by a military dictatorship; he as its head as king.

His country is allied to all intents with Russia.

He has allowed the Palestinian guerilla forces free rein in Jordan – as a militia with armed parades, etc.

He has now even allowed plane highjackers to land in Jordan and transmit their demands for the liberation of captured assassins.

That is your noble host, your ham pal, whom you feel obligated to pay off for a pleasant visit. I reiterate, you have fooled no one, and as others have said, your editorials stink especially when they dabble in politics outside the field of ham radio. Please omit call and address; I don't need assassins on my tail.

Max Sherr
Jamaica NY

Since you are wrong on every count, it would seem that you have not done your homework. If you will open that vault and send a dollar we will send you the Quaker book which will give you the actual facts on all of your allegations. My "pal" Hussein has done everything within his power to stop the terrorists, to the extent of a civil war with tens of thousands of casualties. The military government was not set up until the civil war broke out as Hussein tried to curtail the commandos, before your letter was written. It is Egypt, not Jordan that is allied with Russia. Jordan has received no Russian aid that I know of. Every report of the highjacking emphasized that the Jordan army was powerless to do anything for fear of repraisals on the hostages. Don't be afraid of assassins, only hoots of derision from fellow amateurs who are less biggoted and more interested in facts than hate.

. . . Wayne

FM in New England

I own a Varitronics 1C-2F and so far have been very pleased with it. This is set up with .34–.94 simplex. This leaves four more positions left for other crystals.

I am interested in mobile through out the New England states plus N. Y. What additional crystals would you recommend to key the greatest number of repeaters in these areas?

Also I would be interested in finding out the best way to keep up with information on new repeaters. I am the proud owner of a subscription to 73 magazine and the April *repeater directory* issue is always in the car with the mobile rig.

The men at 73 should be proud of the fact that they run the finest ham magazine in existence.

Harold A. Chamberlin, Jr. D.M.D. W1PFX
2 Old Sudbury Road
Wayland MA

Best bet for frequency "sets" is .34–.94, .94–.94, .34–.76, .76–.76, .31–.88, and the last channel blank, for crystals you might need for a specific area you want to visit (such as .34–.88 for LI, .37–.88 for Staten Island, or .37–.76 for Northern N. Y.).

. . . Ken

Tech Aid Group

I'd like to become a member of the 73 Technical Aid Group. I'm a college student hoping to major in electrical engineering, and I'd like to help Novices with their trials and tribulations. If there's any other information I have to supply you to join the group, please let me know and I'll forward it.

Bob Perlman WB2VRW
3 Joslen Place
Hudson NY

Thanks, Bob. Your name will be entered in the next TAG listing.

. . . Ken

73 for the Blind

Somewhere in the September issue I read about tapes for people with poor sight, to cover the course for the General ticket. I have gone over the issue twice and do not find the article. I have a friend that has a Conditional ticket and is anxious to get the General and I would appreciate the information regarding these tapes. This man is 90% blind.

Arthur T. Becker WA4QZL
R.R. 1, Box 622
Avon Park FL

73 tapes for the blind may be obtained from "Science for the Blind," 221 Rock Hill Rd., Bala Cynwyd PA 19440.

. . . Ken

CW Simplified

Just this week I started my two sons (at their request) ages 13 and 15, on their way to a Novice license.

I had been taught the code years ago by a Navy Wave. The one thing she impressed upon the class was that code is a useful method of communication in which speed is secondary compared to good clean transmission.

The accent was on uniform dits and dahs within the character and uniformity of spacing between characters. Faithfully following rules created code that "sang."

One interesting point stressed was that in the "normal range of hand-keyed speeds, from about 7 to 18 wpm, the speed of formation of the character should never vary. What should vary from speed to speed was the length of the space *between* characters. This had the virtue of tuning the ear to a code character that did not vary with speed of transmission.



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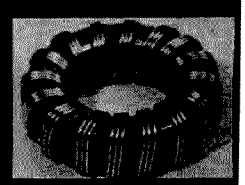
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In listening with a new ear to both the Novice and regular CW segments, it is readily apparent that few people have been exposed to what I have found to be this truth: As the speed of transmission lowers the dits and dahs grow longer and longer, making very difficult copy and failing to train the ear for a true code sound.

The CW bands would clean up considerably if this point could be widely made.

Allan S. Joffe W3KBM

You're Never Too Old

My case history as an amateur radio operator: My first QSO was May 25, 1963, when my age was 74 years, and over the years since that first QSO many close friendships have developed.

In the frames below the call letters W4VGJ are licenses received from the FCC since November 30, 1967. For the reason that the size and poor quality of the picture make reading impossible, they are described.

From left:

1) Amateur Extra Class License dated September 23, 1969.
2) Amateur Extra Class Operator License Certificate, Number AE-6-432, dated September 9, 1969.
3) FCC Commercial Elements 1, 2, 5, Radio Telegraph, Number T3-6-245, dated August 6, 1970.
4) FCC Commercial Elements 1, 2, Radio Telephone, Number P3-7T-4829, dated November 30, 1967.

and

FCC Commercial Elements 1, 2, 9, AM-FM Broadcast Station Operator Authorization, dated August 26, 1968.

The enclosed picture was taken Aug. 20, 1970. My age is 81.

Henry B. Miller W4VGJ
PO Box 1131
New Port Richey FL

FM Anthology

On March 13th of this year, I sent 73 a check (#373, Jensen Beach Bank) for three dollars for a copy of your FM Anthology. Some time passed, and no book was received, although I did receive the canceled check, indicating it had been received and probably spent on a couple of six-packs...

In Orlando, at the hamfest, I spoke to you folks about it, and you said that printing had been delayed, and I should get a copy soon. Wonderful.

Now I see in this month's issue of the world's greatest ham magazine (otherwise known as Green's Folly...) that the books are finally off the presses. But...there are only 500 in print, and everybody had better hurry and send in their three bucks, cause Wayne's running out of beer.

Now I'm worried. Maybe, I think to myself, they'll get rid of all 500 copies of the thing, and forget about me completely. It's keeping me awake nights. Every day I look in the mailbox hoping...but there's nothing there. Except moldy copies of other magazines containing such thrilling articles as "How to Adjust the Catwhisker on Your Receiver to Copy Sideband."

So. . .how 'bout sending me ONE copy of the thing, and end this long agonizing suspense?

Bill Britton WA4IHH
PO Box 707
Jensen Beach FL

OK. The anthology is on its way. For the hundreds of people who have been writing, the anthologies were held up, but now Volume I (at least) is printed, bound, and in the mails. Volume II is not yet printed, and will probably be delayed for another few months. Volume I is made up of the early large issues of FM Bulletin, and it covers the period from Feb 1967 to Feb 1968. The book is a verbatim reprint made by photographing the original bulletins. The price is $3 while the supply lasts.

Volume II will comprise articles from the later issues. Since it has not yet been printed, readers are requested to hold their checks for Vol. II until publication is complete.

. . . Ken

I would like to bring to your attention a possible ambiguity in the advertising of the FM Anthology in 73. I ordered my FM Anthology from the advertisement on page 71 in the May issue of 73. There, in a black bordered box, both Volumes of the FM Anthology are listed at a price of $3 for the two volumes *together*. In the order list at the bottom of the page, the two volumes are listed singularly as "FM Anthology . . .$3." However, on page 85 of 73's August issue, the black bordered box again appears, but this time the two volumes are priced at $3 *each*. Yet, in the order list at the bottom of the page, there is still the singular entry: "FM Anthology . . .$3." Finally, in your September issue, which I just received in the mail, only Volume I of the anthology is listed. My question, of course, is, just what is the price of the two volumes of the FM Anthology?

I have recently acquired two FM units and am at present holding up their conversion to 2 meters until I receive the FM Anthology for the information contained therein. Please advise regarding this confusion, for I am highly desirous of obtaining both volumes.

Gary D. Maples K9VTE
854 North 12th Street
Manitowoc WI

Confusing ain't it? When we first got started with the FM Anthology, we were going to make it one little book with a few selected articles. But we had so many requests for complete back issues of FM Bulletin that we decided to include all of them that were reproducible in a single volume (Vol. I). When Vol. II is printed, it will include all important articles from late issues of FM Magazine. Each volume sells for $3, and consists of article reprints exclusively.

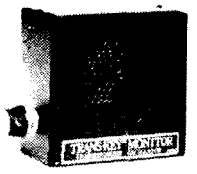
. . . Ken

Repeater Improvement

The Antenna Separation article (September 1970) had the main solution to my problem about close-spaced 2 meter FM repeaters. However, it will cost us some money to get the necessary towers to get the proper antenna spacing both at the Glade Park repeater (portable) and the Redlands repeater (at my home).

"ALL KEYED UP FOR CHRISTMAS?"

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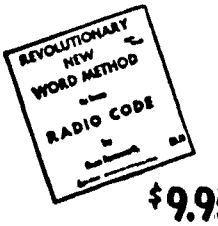
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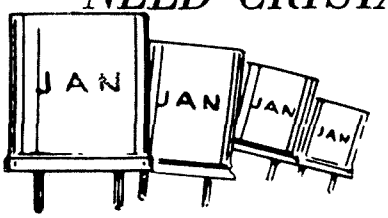
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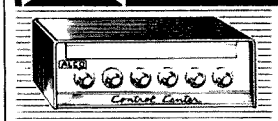
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SCHEMATICS AVAILABLE FROM 73
$1.00 each
ARR-15 from June 1965 73, page 78.
ARC-27 2M Guard Channel Receiver.
SSB Transceiver, Nov. 1961 73, page 23.
R508/ARC, June 1965 page 48, before & after.
73 Magazine, Peterborough, N.H. 03458

Before I can put up a strong self-supporting tower at my house I will have to check with the Mesa county building Code first. If I can't put up a 50 or 60 ft tower here, all I will then be able to do is install a flea-power (up to 5 watts) repeater for the ".34–.94" combination for the convenience of the "tourist" hams on 2 meter FM. For our *search and rescue* work we will maintain the 145.32–146.94 MHz repeater(s) both at the Glade Park and the Redlands sites. I think the suggestions under "The Last Step" (page 53) are very good and regardless of the frequency spacing, we are putting those suggestions into effect. All in all, the article is *super excellent!*

Nate Bale W0PXZ
PO Box 1494
Grand Junction CO

Repeater Snobbishness

In reference to the *Mr. Virgo Himself* editorial (September 1970), regarding clubs that are slowly tightening requirements for membership in repeater groups, what exactly can I expect as a newcomer to 2 meter FM operation? I have purchased old equipment and worked like a dog to make it work, and now I hear I may expect the "cold shoulder" from repeater operators.

My chief interest is operating through the repeater located at Concord, N. H., as I live near Boston and travel every weekend to Lake Winnepesaukee. I wonder if you might be able to answer these questions: (1) Are the Concord repeater operators hostile to newcomers? (2) How can I get in touch with the operators to find out if they will accept a new membership? (3) Is this an "open" repeater?

Thanks very much for your time. I feel that you people are the only ones from whom I can hope to get honest, unbiased answers. I have, by the way, lost all interest in the ARRL, its policies, its politics, its publications, and in general, all that it stands for. Keep up the good job!

Douglas A. Chisholm WA1BLG/1

The Concord repeater is W1ALE, and it is operated by Tony (W1TNO). The fellows on the repeater are quite friendly and go out of their way to be congenial to newcomers. The repeater is open, and no strings are attached. If you wish to become a member of the local repeater association, you can usually contact Tony by calling him on 146.34, the repeater input.

. . . Ken

I sympathize with the ham in Decatur, Georgia – he got turned down by the local repeater club. I got in the local club OK – I paid up for both my wife, K4BGU, and myself, K4ETZ.

Latest development is that one of the local boys who built the Charlotte, NC repeater (W4BFB) took me to task for chewing the rag with a local friend too much. "Sounded like 75," he sez. Told the fellow that nobody seemed to want in or was using the frequency – and we were letting the repeater "tail out" on every transmission to let any possible breakers in. The upshot of the whole thing was that the Charlotte repeater was shut down, I got a letter telling me that I was about to be "tried" for various offenses, and I was about to be shoved out of the

club. But for an estate settlement and an upcoming gallbladder operation, I would have looked forward to the "trial," as the whole thing looked like beautiful grounds for a libel and/or slander suit, not to mention bringing into the open the fact that the *club* had paid for the repeater, not the two who control it and it was about time we stopped bowing reverently in the direction of Myers Park every time we use it! Sure, have "private repeaters" – if the FCC will let anyone get away with it, but .34–.94 must remain open to all comers, period.

Incidentally, I wonder what would happen if someone put in a repeater on, say 146.34 to 147.3? Would a Technician transmitting on .34 wind up in the soup? FCC Rules make it look quite likely. Deliberate jamming is dirty – but a side-by-side repeater operation to another freq above 147 might be the answer to the cliques!

I am a firm believer that any club that either turns down or ejects a ham on other than bonafide legal grounds should be subject to a going over by the attorney general on the usual "discrimination" grounds. Color has nothing to do with it – if the club is to be tax-free, it also must be nondiscriminatory.

F. C. Hervey K4ETZ/Mob 9
%848 E. Frances Street
(Geo Merkl W9GYQ)
Appleton WI

An Orchid or Two

As the author of "The Consummate Console," it was certainly a pleasure to see how very professionally 73 produced the final article and the results certainly justify my time invested in both the building of the unit and the writing about it.

Thanks for doing a fine editorial job. The magazine is improving with each issue, and I'm happy to be associated with it.

Dee Logan WB2FBF
21 Judith Street
Nanuet NY

Your technical articles are *the best* that I have ever seen and your theory series is superb! I'm too broke to have a subscription to 73 but I buy old copies and read them cover to cover – especially Wayne's editorials.

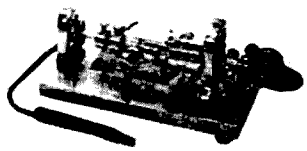
Bill Kresl WB9BBC
1109 Sherman
Janesville WI

My subscription to 73 should precede this letter by a day or two and I thought I might include a thought or two on becoming the proud owner of a share in what seems to me to be the most needed boost to ham morale that has appeared on the scene in a while. I think 73 is the innovation which could help to recoup and develop what would appear to be a sadly declining spirit in the ham fraternity All we need is a new national organization, for which 73 could be the house organ, and we would be ready to go down the road.

Congratulations to Dave Mann for an outstanding bit of editorializing (*Leaky Lines*, issue 118). I wonder how many of us medium-generation-gappers would have the courage to so aptly express the ideas put forth for consideration. I agree 100% with the very fine content of the material and concur wholeheartedly with the

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concluding paragraph. I would think that those so vehemently deny the right to dissent and the freedom to express opposing views should review the events surrounding the period centering on the year of 1620.

Raymond M. Drew K1BGT
Box 36 USNSGA
FPO NY

73 Double Bonus

I am a subscriber. I like the magazine. It is however very difficult for me to understand why you waste valuable space which could be sold to an advertiser by carrying the "73 Reader Service." Three issues ago I marked three boxes for further information on advertised products. To date I have never received anything from any of them, which leads me to believe that my request was never processed and probably went into the wastebasket. Three weeks ago I checked a single box so far I have heard nothing.

Alfred G. Waack W4YHB
Box 1909
Hendersonville NC

73 sends the names of inquirers to dealers and manufacturers. If the dealers and manufacturers really care, they send you info. If not, they don't. Often, our advertisers aren't set up to handle inquiries and thus let their correspondence build up.

. . . Ken

Hobby Band

Relating to creation of a 220 MHz beginner band, I am astounded as for years I have advocated there be some type of band for beginners. The FCC rules as now set up help create disrespect for law and order. When we have conditions which breed the CB cult, etc. and $20 filing fees which only make the CB'ers more lawbreaking (why pay when you can do it for nothing. . .) and so forth – there is something serious and wrong. However, I have never been able to get Wayne to accept this line of thinking, and for him to all of a sudden come out in favor of doing something to help ham ranks and manufacturers. . .well I am shocked and wonder more than anything else who talked him into it. And, I am also led to question Wayne's honesty in saying in print, "hey, fellows, here is this great idea I got," when in fact others have been pressing modified forms of that idea on him for so long they are tired already. . .

Art Brothers W7NVY
Box 2124
Reno NV

Wayne never claimed authorship of the idea – he claims only to back it as published.

. . . Ken

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Since we have tremendous ragchewing on the FM channels here in Germany with transmissions in the hours I would appreciate it if you could investigate the possibility of sending me a tape on any of the internationally used recording speeds with a typical FM channel taped in the U.S. I would return the tape as soon as possible or could also furnish you with a tape if that would be more convenient.

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(taxis, etc.), as well as by the police, so that nobody can understand here that your repeaters limit transmissions to one minute or so.

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Perhaps our readers can help. As to the ragchewing, someone should suggest the possibility of an emergency occurring in the middle of a long transmission. One longwinded ragchewer could tie up a repeater so that it would be unusable in such an event. Ragchewing is great . . .just allow a dropping of carrier every minute or so to accommodate unexpected contingencies. . . . *Ken*

The Great Controversy: IL

It is about time we should speak up. This applies to both oldtimers and new fellas. Rather than raise a fuss, we sit back hoping the right thing will turn up for us. I have been watching the Incentive License (IL) fracas and finally decided to say my piece!

Having been a member of ARRL for many years, I was one of those who thought ARRL was for the ham – but its manner in railroading through the licensing deal caused me to drop out two years ago. On such a serious subject an action should have called for a membership vote. Hence, I can only deduce they sold us down the river. At the same time, though, they have done some good during past years and we should recognize that for what it is worth.

I would like to suggest a plan regarding this (IL) mess we are in and hope that you will take time to evaluate with serious thought. We all know that one person or a few do not have a chance of swaying FCC and I doubt if any one portion of the IL ruling could be altered to favor one group of hams. By the same token, you can't barrel into FCC with a tirade in what we consider the unfairness they have created by their ruling and law concerning IL. They are in the driver's seat and you might as well accept the decision; however, diplomatically approach them on a different angle. "Incentive" is a word that implies something to work for, not to take away what you already have earned, and then say "If you wish to have your frequencies back – take the highest license exam there is and pay us a fee!" It was quoted in one paper remarks to the effect that FCC could gain so much money by all the hams rushing to pay their fee and get back their frequencies taken from them. What a farce! I think by now statistics will prove to them that this is not the case. IL has proved to be the saddest excuse of eliminating many oldtimers and potential hams.

Let us consider what must be done to make satisfactory changes for all without the degrading aspect. The best plan in my opinion would be for FCC to revert back to all conditions as to frequencies, allocations, etc. prior to IL. This puts us all back on an even keel. Then offer a plan that is a real incentive. Broader the phone bands since this phase of operation is jumping ahead by leaps and these boys should have additional room for expansion. After all, the Canadians' phones are messing up the Novice bands – move the Novices down 50 to 100 kHz for the phone boys on these two bands. Add to

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this 50 kHz phone expansion on 14 and 21 MHz. FCC could even go so far as to offer CW fellas a new 25 kHz segment (6975 to 7000 or similar) for incentive. At least offer some real incentive to hams over and above what they presently have.

Now that we know what line of thought to pursue, how does one approach FCC to get a favorable hearing? In preparation – first it will take thousands of active and inactive ham signatures who want to see real justice done. The 73 organization has taken one step with its half-sheet tearout form to be returned to 73 mag (September 1970). Now arrange for a special meeting with FCC by a group of amateurs selected by vote of U.S. hams. IL could then be planned with fairness. ARRL had this chance if only they had given their members the right to vote (along with thousands of hams who were not ARRL members).

I'm sure that proper presentation to FCC with signed statements would cause them to reevaluate their incentive licensing program.

W. Dale Marshall W7DJU
3208 Plymouth Drive
Bellingham WA

I would like to get some thoughts off my gut. First, I hate IL, I don't belong to ARRL any more because of their part in it.

I would like to see ham radio put back like it was before November 1968; it would be a lot more fun for me and those to follow us.

G. L. Burkett
311 N. Washington
Evid OK

Rudeness with Reason

I am writing to apologize for our rudeness when we walked out on your speech Saturday night at the North Alabama hamfest. My husband and I were looking forward to seeing you and when he felt slightly bad before we arrived he said he wanted to see you too much to let a little pain stop him. The pain became too much to bear so we had to leave. It turned out to be appendicitis. He's doing fine now that his appendectomy is over.

I know he was sorry to miss you, and I think he would want you to know that he left because of illness and no other reason.

Though I'm not a ham I find 73 a very interesting magazine and the editorials refreshingly outspoken.

Sally Taylor WB6BDL/4—XYL

QSY Anyone?

Both Wayne and Ken have refreshing approaches to various subjects. Much food is offered for thought. I don't always agree with the viewpoint(s), but give 73 credit for taking a stand on issues.

Rather belatedly, a reply to Dave Mann's editorial describing two OTs and their experience with W1AW coming on frequency: It seems to me that it would be rather impractical for a station such as W1AW to check *each* frequency

on which it simultaneously transmits since there are so many, a problem of rather some magnitude would evolve and possibly more if transmission on any single frequency had to be delayed.

W1AW has been around a long time – as long as I can remember and longer than most of the hams today. It carries on a service for which many are grateful – when *they* can copy through the QRM. The times and frequencies of transmission are published as they have been for many years!

How quickly so many years of good are forgotten in a fleeting moment of aggravation or disagreement! Are those *particular* minutes, that *particular* frequency so precious they cannot be surrendered for a helpful service unselfishly given?

Paul Pagel K1KXA
4 Roberts Road
Enfield CT

What's Wrong?

Repeaters on calling, monitoring, and emergency channels such as the nationally recognized 52.525 and 146.94 MHz, in particular. These actually hinder amateur radio, as they encourage poor operating and maintenance practices, a let-somebody-else-do-it attitude, cause untold interference to simplex operations, sometimes at far greater distances than the repeater normally covers, and in the end completely discourage simplex operation and promote a "communal" type of operation.

Poor operating, maintenance, and construction practices: To go into detail, the stations that have no way to measure their deviation, so merely set it way too high to be sure; They don't seem to know that they lose, rather than gain, performance through this practice. Power in excess of that necessary to do the job at hand: Experience in this mode of operation will tell anyone who is observant that power outputs in excess of 60 to 90 watts is simply that much more useless QRM; Sure, you'll get some nice signal reports, but what good is a signal report from a station with a sick receiver? Why should he bother to repair his receiver if he can hear somebody full quieting? If you have adequate antenna height, you can cover hundreds of miles with 25 or 50 watts; if you don't have the height, why QRM stations you can't hear because of your poor antenna?

Operating practice: There seems to be more and more of the "lumbago net" type activity these days on FM; The "long talker" will always be with us, but they should be discouraged from cluttering a channel with their hems and haws for hours; The way to do this is to use terse operating procedure yourself, and don't talk with the sciatica gang; The same goes for the drunks – amateur radio can live without the stigma of alcoholism. The Senile Operator: I don't know, but it sure gets hard to listen to by the hour.

Lastly, the attitude that FM is only good for 10–20 miles; Rats! You get out of it what you put into it, just like anything else. Of course, if you can't seem to get the antenna up over 20 ft, or afford a good feedline, just crystal up for the local repeater and they'll hear you 200 miles away while you're discussing your lumbago with Joe down the road. Fine. Rental Radio – just what ham radio needs! It's the next thing to communism – but don't say that to a repeater owner or user!

Bill Harris K9FOV
414 Bomberding Ave.
Lafayette IN

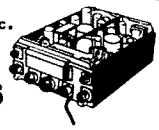
You may have a few legitimate grievances, Bill, but you're living in the past if you think 146.94 MHz is nothing more than a national calling channel. Whether we like it or not, whether we agree or disagree, whether we approve or disapprove, the plain fact is that 146.94 MHz is first a national repeater output frequency. The amateurs of today have made it so.

. . . Ken

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No one likes to go into a store without buying something, right? It is the same with these information requests. You will be expected to buy something. Oh, it doesn't have to be a $50,000 antenna system, but it should be something modest . . . a transceiver . . . a linear . . . you know. We'll leave the decision up to you, knowing that we can trust you to do the right thing.

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Call_____

Address_____

_____ Zip_____

PROPAGATION CHART
J. H. Nelson
Good O Fair (open) Poor☐

November 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
1	(2)	(3)	(4)	5	(6)	(7)
8	9	[10]	[11]	12	(13)	(14)
(15)	(16)	17	18	[19]	20	(21)
(22)	23	24	(25)	(26)	(27)	28
29	30					

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	7	7	7	7	7	14	21	21	21
ARGENTINA	14	14	7	7	7	7	14A	21A	21A	21A	21A	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14B	14	14	21	21
CANAL ZONE	14	7A	7	7	7	7	14	21	21A	21A	21A	21
ENGLAND	7	7	7	3A	7	7	14	21	21A	21	14	7
HAWAII	21	14	7B	7	7	7	7	7B	14	21A	21A	21
INDIA	7	7	7B	7B	7B	7B	14	14	14	7B	7B	7
JAPAN	14	7B	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO	14	14	7	7	7	7	7A	21	21A	21	21	21
PHILIPPINES	14	7B	7B	7B	7B	7B	7B	14B	7B	7B	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	7	7	7B	7B	14	21	21A	21A	21A	21	14
U. S. S. R.	7	7	7	3A	7	7B	14	21	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21	21A	21A	21

CENTRAL UNITED STATES TO:

ALASKA	21	14	7	7	7	7	3	7	14	21	21	21
ARGENTINA	21	14	7	7	7	7	14	21	21A	21A	21A	21
AUSTRALIA	21	14	14	7B	7B	7B	7B	7B	14	14	21	21
CANAL ZONE	21	14	7	7	7	7	14	21	21A	21A	21A	21A
ENGLAND	7	7	7	3A	7	7	7B	14	21	14	7B	7
HAWAII	21	14	7A	7	7	7	7	7	14	21A	21A	21A
INDIA	7	7B	7B	7B	7B	7B	7B	14	14	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7	7B	7A	21
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	7B	7B	7B	7B	7B	7	7	7B	7B	14
PUERTO RICO	14	7A	7	7	7	7	14	21	21A	21A	21	21
SOUTH AFRICA	14	7	7	7B	7B	7B	14	21	21A	21	21	21B
U. S. S. R.	7	7	7	3A	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

ALASKA	21	14	7	7	7	7	3	3	7	14	21	21
ARGENTINA	21	14	14	7	7	7	7	14A	21A	21A	21A	21
AUSTRALIA	21A	21	14	14	7	7	7	7	14	14	21	21
CANAL ZONE	21	14	7	7	7	7	7	14A	21A	21A	21A	21A
ENGLAND	7B	7	7	3A	7	7	3B	7B	14	14	7B	7B
HAWAII	28	21	14	14	7	7	7	7	14	21A	28	28
INDIA	14	14	7B	7B	7B	7B	7B	7	7	7	7B	7B
JAPAN	21A	21	14	7	7	7	7	7	7	7B	7A	21
MEXICO	21	14	7	7	7	7	7	14	21A	21	21	21
PHILIPPINES	21A	21	14	7B	7B	7B	7	7	7	7B	7A	21
PUERTO RICO	21	14	7A	7	7	7	7	14A	21A	21A	21A	21A
SOUTH AFRICA	14	14B	7	7B	7B	7B	7B	14	21	21A	21	21B
U. S. S. R.	7B	7	7	7	7	7B	3A	7B	14	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21	21A	21A	21

A = Next higher frequency may be useful also.
B = Difficult circuit this period.

amateur 73 radio

A
123
One Dollar
December
1970



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BUILD YOUR OWN SOLID-STATE EXCITER

"DELTA f" SSB CONTROL

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PLUS

FM • FUN PROJECTS • HUMOR

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#123 December, 1970

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The Cover

An impressive shot of the sky through K9JFD's beam. The photo was submitted by Mrs. Gene Markos as a birthday surprise for hubby.

Amateur Radio News Page

December MCMLXX | Monthly Ham News of the World | 73 Magazine

CHICAGO OUTLAWS HAM RADIO!!

CHICAGO AMATEUR CLUB BRINGS SUIT

Chicago. Under city zoning ordinances, Chicago has forbidden amateur radio stations to be set up in residential areas. According to information published in the Chicago Daily News, the ban can only be waivered on payment of a special $100 fee.

Proceeding on the grounds that such anti-ham legislation is unconstitutional, a group of Chicago amateurs (the Chicago Area Radio Club) filed suit in district court, charging the city with attempting to regulate a service that is already being regulated by the federal government. The suit seeks to have the U.S. district court enjoin the city of Chicago from enforcing its ordinance and from collecting fees for waiving such ordinances.

In supplying this information to 73 News, Art Housholder (K9TRG), manager of Spectronics, Inc., a Chicago area ham radio firm, said the action of the city and the counteraction on the part of the CARC were topics of



U.S. Navy Radioman First Class Larry Hollingsworth sets up personal phone patches for crew members aboard the frigate Yarnell, reducing the impact of transglobal separation between family members.

discussion at club meetings around Chicago and on ham radio nets. Most of the comments, he indicated, were directed against the inequitable city ruling. He also expressed concern that should the court favor the city rather than the amateur operators, other metropolitan areas might follow suit, dealing a crushing blow to amateur radio.

NO-MONITOR REPEATER OPERATION PROPOSED

The editor of 73, Ken Sessions (K6MVH), has submitted a proposal to the FCC that calls for toned repeaters to be allowed to operate without the requirement for UHF monitoring. Under present rules, no remotely operated repeater may be used unless the specified repeater licensee is monitoring from the UHF control point stipulated on his license. The rules make it impossible for the sole owner of a repeater to operate his repeater from a mobile or from any site away from his control point.

Sessions' proposal would make it legal for continuous monitoring to be abandoned when certain fail-safe measures and tone control have been incorporated into a repeater system. Tone-burst and whistle-on repeaters, under the proposed ruling, would require no fixed-control-point monitor as long as effective automatic measures have been incorporated into the repeater design to suspend operation of the repeater when its emissions deviate from the rules of the Commission. Untoned repeaters would continue to fall under existing rules.

MODERN NAVY USES HAM RADIO AS MORALE BOOSTER

Lucius Seneca, an ancient philosopher, once said, "It is through the essence of letters that friends are, in a manner, brought together."

Although Seneca was talking about letters one writes, his thoughts can also be applied to the call letters of ham radio station WBØBDH. aboard the guided missile frigate USS Harry E. Yarnell, presently circling South America on Unitas XI operations.

Bringing people together via ham radio and telephone patches is the off-duty "pleasure" of radioman Larry Hollingsworth. "It is a pleasure to be able to set it up so one of the men on the Yarnell can talk to his wife or girlfriend back in the States," emphasizes Hollingsworth.

Running WBØBDH is Hollingsworth's hobby. His main job is radio watch supervisor and controller at Yarnell's communications division.

Instrumental in establishing WBØBDH before Yarnell departed her home port at Newport, Rhode Island, Hollingsworth obtained an FCC license and was designated supervisor of the amateur radio activity.

"It has really been fantastic," Larry says. "We have been gone two months and I have completed almost 400 calls. It is a real morale booster when we are 8000 miles from home."

Unitas is an annual training exercise involving the United States and the major maritime nations of South America. Larry and the Yarnell will circle South America and return to the United States in mid-December.

A real asset of the service has been demonstrated in situations where an emergency is involved. One chief petty officer on Yarnell received a letter from his wife saying they had suffered a very serious fire in their home. "The letter lacked many details which were important to the chief so we placed a call home via the ham setup," Hollingsworth stated.

A Navy wife, who is presently living in Norfolk, Virginia, and whose husband is on the Yarnell, in a letter to the Yarnell's commanding officer, wrote: "Larry's efforts have certainly helped bridge the miles between my husband and myself, and those four wonder words, 'I love you – over,' have kept us close in spite of the miles that separate us. It is warming to know there are those who understand the voice of a loved one can make a long separation at least bearable."

"We really have received outstanding cooperation from ham operators throughout the United States," the radioman said. "Almost all phone patch stations we contact seem more than willing to help us place our calls."

He does encounter the humorous aspect also. He was talking to an operator in the midwest one evening and the man agreed to make phone patches for Yarnell men. However, the operator's wife was using the phone and after ten minutes of idle chatter over the airwaves, Hollingsworth finally had to thank the man and sign off.

Originally from Albia, Iowa, Hollingsworth presently makes his home in Middletown, Rhode Island, with his wife Lynda and two children, Lee and Lynette.

Larry is anxious to talk to any operators in the world who would like to contact him on the air or by writing to him in care of the USS Harry E. Yarnell (DLG-17), Fleet Post Office, New York. Phone patches to the States are actively sought and QSL cards are available.

GALAXY MOVES TO LINCOLN: Something Big in the Offing?

Lincoln NB. The acquisition of Galaxy by Hy-Gain is now complete, according to R. A. Kobold, spokesman for Hy-Gain Electronics. The company has brought all Galaxy's operations from Council Bluffs, Iowa to Lincoln, Nebraska. Kobold hinted of some sparkling new products to be evolving from the merger, but would not be specific as to detail.

Galaxy watchers seem to think an unveiling of something new could take place at the big SAROC convention in Las Vegas this coming January. According to reports from within Hy-Gain's executive offices, the company has reserved six booths for the occasion. This "extravaganza" attitude could point to an announcement of something the company feels spectacular.

AMATEURS IN ACTION

Coast Guard Commends Ham For Meritorious Service

Washington, D.C. Admiral P. G. Prins has personally expressed thanks on behalf of the U. S. Coast Guard to J. P. Corrigan, a radio amateur who provided communications with a ship at sea during a personal shipboard emergency.

In a letter to Corrigan, the admiral reported: "On the afternoon of August 26, it was reported that the radio operator on (the ship) Stella Lykes had apparently suffered a heart attack. This denied normal communications with the ship and required that all information be passed through the ship's amateur radio. From that time through the evening of August 29, when the ship arrived in Honolulu and transferred the patient ashore, you maintained highly effective communications, passing medical advice for the U. S. Public Health Service, rescue operations information for the Coast Guard, and port arrangements for the ship's agent, Oahu Railway and Terminal Warehousing Company."

By way of expressing the appreciation of the Coast Guard, Admiral Prins said, "Your diligence and constant willingness to help are noted with pleasure. I feel that this has been an outstanding display of the humanitarian spirit of amateur radio operators everywhere."

Copies of the admiral's letter were sent to the Lykes Brothers Steamship Company, employer of the cited amateur, to Oahu Railway and Terminal Warehousing Company, and to the U. S. Public Health Service in Honolulu.

EARLY 73 BRINGS $25!

The January 1961 issue of 73, good copies of which sold just three years ago for as little as $10, now is bringing $25. This issue, one of the rarest of the early 73 issues, was bid to the $25 price at the ham auction at the ARRL National Convention. This issue featured the first published circuit for the RCA Nuvistor and was in wide demand during the early 60s. Now, with JFETs and things, the issue is more of value as a collector's item. The article on using the Eico modulator with the Johnson 6N2 also helped make that particular issue rare.

HAM OPERATOR HELPS BOY GET CRITICAL OPERATION

(Reprinted from Florida Skip)
by WA4ABY

Josef Darmento (W4SXX) has won the recognition of his community and the plaudits of the ham radio fraternity for his assistance in helping a small Italian child receive a crucial heart operation. His able use of ham radio paved the way for 4-year-old Fabio Piampiani to undergo a heart operation last month by Houston's famed Dr. Michael DeBakey.

On June 9 Joe intercepted an urgent plea on 20 meters from I1BAX, Roger, a doctor in the Adriatic Sea fishing village of Civitanove. Roger outlined to Joe that the child had an atrophied right ventricle and would die if he didn't get an operation within three months. Responding, W4SXX then contacted his wife visiting in Austin, Tex., who in turn talked with Dr. DeBakey in Houston. The famous pioneer of heart transplant surgery gave his tentative approval for an operation at no charge, if the child could be brought to Houston.

Darmento, a Merritt Island resident and a physicist with the Air Force Eastern Test Range, relayed this information back to Italy and arrangements were made for the boy's trip to the United States. Concerned Italians donated nearly $6,000 so the boy could receive another chance at life. Finally, during early July little Fabio Piampiani made the trip from Rome to New York and on to Houston. W4SXX enlisted the aid of three New York hams

HAMS CITE

IN CONGRESSIONAL RECORD

*Washington, D'C'*The Honorable Emilio Daddario, Connecticut appointee to the house of representatives, pointed to the service of U.S. radio amateurs during a meeting of the house in September. From the Congressional Record comes the account of Daddario's speech, which said in part: .

. .I rise today to call attention of the House to the valuable services performed by amateur radio operators — "hams" as they are frequently called. Operating their own private radio stations, hams render emergency assistance in providing communications during disasters such as Hurricane Celia. We have all read accounts of such activities and are well aware of the invaluable help these volunteers provide. What is not so well known is the continuing assistance hams provide in alleviating a most human problem — the loneliness and suffering that comes from the separation and lack of communications between our servicemen and their families. Those of us who daily see our wives, children, and close friends forget that there are hundreds of thousands of young people whose contact with their families is limited to letters and occasional photographs. Like the concerned public servants they are, hams have stepped forward to lend their aid and provide radio communications facilities so that servicemen abroad can talk to their loved ones at home. Using "phone patch"

OVER 2000 ATTEND ARRL NATIONAL IN BOSTON

by W2NSD

The Boston ARRL National Convention was an unqualified success this year with well over 2000 amateurs and their families in attendance, setting a record for ARRL National Conventions in recent years.

The sad part was the tiny display area, a far cry from a few years back when most of the manufacturers in our hobby supported these National Conventions. Outside of a few distributors, the main displays were by Drake, Mosley (Carl himself was there, by gosh!), Cushcraft (Les Cushman was there!), National, Swan, Signal One, etc., plus a few newcomers such as Ten-Tec, Ehrhorn, Lee, etc. Even the most avid scrounger of data was hard put to spend more than a few minutes in the exhibit area.

As outlined last month, pressure from HQ prevented the convention committee from permitting any 73 personnel from participating in any way in the programs. Fortunately 73 was able to get a small auditorium room for one of the convention days and hold several FM forums, meetings and discussion groups, show slides of Jordan, discuss incentive licensing, and keep conventioneers from starving to death with good New Hampshire freshly squeezed cider and homemade donuts. Many thanks were received for the feed from convention goers with either stunned pocketbooks or stunned taste buds from eating at the local restaurants.

The proliferation of local hamfests and conventions has put a strain on the larger manufacturers, but perhaps they should make every effort to save enough time and money to support a national convention, for without their support a convention looks more like a small-town picnic and is disappointing to amateurs who have come from afar for the expected gala affair.

Lele Defilippis (HB9AMY), at right, poses with two others of his recent all-band DXpedition to Liechtenstein. QSLs are to be mailed to HB9AMY. Box 768, Lugano 1, Switzerland.



(K2JSO, W2IOM, and WB2CBP) to assist the boy's mother in finding the right plance from JFK airport to Houston.

Sorrowfully the child died on the operating table July 12. But at least the boy had a chance at life he wouldn't have had if it weren't for ham radio.

In an editorial entitled Humanitarian Ham, the newspaper Cocoa Today said, "We think this is a fine example of man's humanity to man."

For his pivotal role in this outstanding example of the good in our hobby, Florida Skip last month saluted Josef Darmento as "Ham of the Month."

equipment coupled directly to their own radio receivers and transmitters, hams call friends and parents of servicemen on the telephones and let them talk to their absent soldier in Vietnam who use military radio facilities over there. Acting as the vital link, the ham provides a much needed human contact between individuals separated by the war.

RADIO AMATEURS "FILL IN" FOR LOST LANDLINES

*Cuba, NY.*When a work crew accidentally cut through an underground telephone cable recently, the local civil defense group was alerted immediately, bringing to life an organized communications network revolving around a 2 meter FM repeater.

According to Gailerd Perkins (WB2IDQ), eleven stations, working through the Mt. Chaos repeater (WA2UWT). were deployed at key positions to plug what the Ocean Times Herald referred to as the "telephone gap."

Volunteers manning mobile radios supplied through the CD office's RACES network – and some CB'ers – patched together an emergency network by which the Cuba Memorial Hospital and the fire, police, and ambulance services of the community could maintain instant contact.

A local CD official said that no real emergency arose during the phone outage, but the network was ready and operative "jus[illegible]e."

INTERNATIONAL NEWS

Swiss Government Okays FM Repeaters

Switzerland. The Swiss Government has given the go-ahead to amateurs who want to put up repeaters on the 2 meter and 450 MHz amateur bands. Due to the narrow operating spectrum in the 2 meter band only the input or output of a repeater can be placed in that band: the other end of the repeater system must be placed in the 450 MHz region.

Swiss amateurs are expected to set up their repeaters with inputs on the 2 meter band where they can make most effective use of mobile range.

MARS Ops Break UHF DX Record

U. S. Hq., Ft. McPherson, Ga.– Bill Byrd (WA4HGN) of Muscle Shoals, Ala., and Paul Wilson (W4HHK), of Collierville, Tenn., set out to break the UHF DX record, and break the world record they did!

Bill and Paul are both amateur radio operators, and members of the Third U. S. Army Military Affiliate Radio System (MARS), as AD4HGN and A4HHK, respectively. Both are inveterate experimenters, anxious to advance the "state of the art" in their avocation

From IARU Region 1 News: "AROUND THE REGIONS"

AUSTRALIA:

The Wireless Institute of Australia has secured permission for the use of slow-scan television on all amateur bands as authorized in Australia. The bandwidth of emissions shall not exceed that of an A3 signal. Identification is to be by call sign in visual form on the televised picture and by telegraphy on the telephony sound channel.

BULGARIA:

The 7th National Convention of the Central Radio Club of Bulgaria was held on 26 April 1970 in Sofia. Delegates from amateur clubs approved the methods of development of amateur radio in Bulgaria. The convention called for further development of SSB telephony and VHF/UHF amateur communications in this country.

DENMARK:

The following information concerning reciprocal licensing has been submitted by the Danish Posts and Telegraphs.

The Danish General Directorate of Posts and Telegraphs is prepared to consider applications from aliens provided that they will stay in Denmark for a reasonable period of time and provided that they have a certain firm connection with Denmark.

case whether a license will be granted or not. If a license for operation in Denmark is granted, this will be done without a renewed technical examination and code test.

GERMANY:

The Distrikt Niedersachsen has plans to establish another training course in Wolfsburg which is supposed to take place during the Easter holidays of 1971. Talks with the management of the Wolfsburg Youth Hostel have already been opened and it is most likely that the course will materialize.

The training will include lectures on techniques, laws, and regulations for amateur radio, and training in Morse code.

GHANA:

The latest edition of "9GI News" reports the tenth anniversary of the inauguration of the Ghana Amateur Radio Society. The number of licensed amateurs in Ghana is now shown as 40.

MALTA:

The Malta Amateur Radio Society has obtained the use of a historic building, known as the Zabbar Gate, for use as its headquarters. The building originally formed part of the fortifications erected by the Crusaders. The

NIGERIA:

NARS reports considerable interest in amateur radio at the Kaduna Polytechnic from where a station is active under the call 5N2KPT. The licensee of 5N2KPT is David Wilcox, G2FKS. It is hoped that arrangements can be made to acquire, without payment of customs dues, equipment suitable to start a club station. Certainly it seems right that an educational institution should be able to obtain a concession from the authorities.

SWITZERLAND:

In Switzerland there were 917 amateur licenses in force at the end of 1969. Membership of USKA at the same date totaled 790 full members and 655 associates.

The regulations governing amateur radio have undergone some slight modifications in 1969. The minimum age for obtaining a license was lowered from 17 to 15 years. Operation of repeater stations is allowed on 450MHz and 2m.

USA:

The Foundation for Amateur Radio Inc., a nonprofit institution devoted to advancing the interests of amateur radio with its headquarters in Washington, D. C., announces the esta-

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Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business venture. No display ads or agency discount. Include your check with order. Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February. Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads. We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue. For $1 extra we can maintain a reply box for you. We cannot check into each advertiser, so Caveat Emptor. . .

DIGIT ONE CONTROL DEVICES: Decoders, encoders, logic processors, autopatch, power supply. Compact, plug-in solid-state modules. Application Notes/Catalog. Write Digitone, Box 73-ST, Bellbrook, OH 45305.

ROCHESTER, N. Y. will again be headquarters for the huge W. N. Y. Hamfest, V. H. F. Conference and Flea Market, May 15, 1971.

CLEGG VENUS 6M SSB TRANSCEIVER, matching AC 416 supply, speaker; excellent, $250. Also NC-98, matching speaker; good, $55. K1EOP, 1234 Ridgebrook Ct. S. E., Grand Rapids MI 49508. Tel. (616) 455-1594.

FOR SALE OR TRADE: Frequencie Meters BC221; TS174; TS323. All with Powersupply and Modulation. Lampkin 205A Deviation Meter. Make offer for cash or trade for Griddiposcillator; Distortion Analyzer, RF Volt meter or what have you. K5IDD Walter Tilleman, 351 Furr Drive, San Antonio TX 78201.

RED HOT! 5RK Delta Tri-bander — Sensational breakthrough in Delta Loop design. Proven outstanding DX ant. Highest quality; also heavy duty high performance quads. Check our low prices. Island Electronics 4102 Ave. S., Galveston, Texas 77550.

NOVICE CRYSTALS: 40-15M — $1.38; 80M — $1.83. Free flyer. Nat Stinnette Electronics, Umatilla FL 32784.

FABULOUS OLD TIME RADIO SHOWS on tape. Drama, comedy, mystery. Catalog $1.00 (refundable with order). RADIO RERUNS, P.O.Box 724, Dept. 73, Redmond, Wash. 98052.

2M FM - GALAXY FM-210. Complete with power booster for mobile or 115V operation. Used for 73 tests only, $200. less crystals. Wayne Green, 73 Magazine.

FABULOUS CONDITION! SB301 Receiver with 400 Cycle CW Filter, $265; DX60A Transmitter and HG10B VFO, $70. Jan WB6VRN, 1201 Grand Vista, Monterey Park CA 91754.

SALE: Super Pro 600 for Rack Mount. J. Modeste WA2LGJ, 615 Casanova St. Apt. 1, Bronx NY 10459. Tel: (212) 329-0147.

SR-2000 AND AC SUPPLY, realigned by 1st, will ship purchaser's expense, best reasonable offer. J. Richeson, Yolo High School, Rt. 1 Box 1900, West Sacramento CA 95691.

I5 JOHN F. RIDER PERPETUAL TROUBLE SHOOTER MANUAL for sale — $350 — or would trade for Swan-270-OR-Heath-101 — OR sim. Trnscvr. I. S. Olson (Wn6agb) Box 337, Mendocini CA 95460.

THE 20th ANNIVERSARY DAYTON HAMVENTION will be held on April 24, 1971 at Wampler's Dayton Harra Arena. Technical sessions, exhibits, hidden transmitter hunt and an interesting program for the XYL. For information write Dayton Hamvention, Dept. 7, Box 44, Dayton OH 45401.

SELL APACHE XMTR with SB-10 Adaptor, $100. Also Drake 2B w/Xtal calibrator & spkr, $180. Paul Reuter, W-9-Rov, Robinson IL 62454. Tel. (618) 544-2234.

EDITORIAL

THE NAURU CURSE

by Dan Whitsett W4BRE

Of the 300 or so countries I have worked the past four years, two or three stand out as being unusually exciting contacts. These stand out not necessarily because they were the most rare, but because of the effort I had to put out to get them – or maybe the unusual manner in which they were worked. Just recently I made what has to be one of my two most exciting DX contacts. Nauru is certainly not the rarest catch on the band, but for some reason it had eluded me throughout my DX chasing. I had seen in the various DX columns and magazines where the fellers were occasionally working Nauru, but never once did I hear him. The main reason was perhaps that his operating hours would have meant for me to be on between 1–4 a.m., and I felt confident that someday I would find him on during my regular hours. The months went by and still no Nauru. The call changed from VK9 to C21, and I continued to look for him. Then my confidence began to fade, as I began to read that the only operator there, C21JW, would be closing down for good very soon.

Then I saw in Gus' "DX'er" that the middle of June was the deadline. I had one week to find and work C21JW – a station that I had not been able to find for 27 months.

So, with seven days in which to get the job done, I set my alarm clock the first night for 1 a.m. Listening until 4 a.m., I didn't hear anything of C21JW, WA6FYC, one of the guys I had asked for assistance on the first night of this "mission impossible." He told me that C21JW was on 14.128, and that he would try to break them, and hold him for me. I leaped out of the bed, and like Jim Ryan setting the world's record four-miler, I dashed into the ham room, turning on every switch I could find.

Just knowing that he was on the air, and that I knew what frequency was more than I could handle and still keep cool.

Just as the receiver warmed up, I heard WA6FYC on CW on 14.128. Then some Australian came back to him and said, "Sorry OM, but C21JW just QRT'd, and QRT'd for good, since he's packing up to leave Nauru."

There is no way in the world I can explain my feelings upon hearing those words . . .but I believe every true DXer will know the emotions I felt.

But then, I heard a "break," and a voice said, "This is C21JW, I'm still listening." Oh Happy Day! My heart almost leaped out of my chest. Even though he stood by for WA6FYC I started pounding the keyer, "C21JW DE W4BRE PSE PSE PSE K."

He came back, he came back . . .I've got him! Oh hang on . . .don't have a heart attack yet . . .please hang on until we exchange reports.

He turned it to me, I gave him a report and I was in the process of asking him to listen for me in the

of radio communications. They have conducted endless experiments; designed, built, and modified equipment, much of it furnished by MARS; and tried new techniques in preparation for their record-breaking communications feat on 2300 MHz this summer. Bill, father of three, works for the Tennessee Valley Authority as an instructor of student generator plant operators. Paul, also married and the father of two, is a television broadcast engineer for a station in Memphis, Tenn.

On July 9, Bill drove a panel truck to a place called Sunset Rock near Bon Air, Tenn. Inside the truck was seemingly enough exotic radio equipment to monitor a space flight, and on a trailer behind, looking not unlike a large mechanical turtle, was a specially tuned and rigged 10-ft. dish antenna.

Working from an elevation of nearly 2000 ft. above sea-level, and using an astrocompass to point his dish antenna in precisely the right direction, Bill first attempted to contact Paul on the morning of July 10. Repeated attempts that first day were unsuccessful, but early on July 11 another call brought the looked-for response: "This is *W4HHK reading you loud and clear!*"

The record thus established was for 249 statute miles, as established by aeronautical charts. And the record is now official, having been recognized early in September this year by the American Radio Relay League.

To the uninitiated, the distance may not seem very astounding in this age of moon voyages and globe-girdling communications. But the record set by Byrd and Wilson was at a frequency of 2.3 GHz – approximately four times as high as that of the highest-frequency UHF TV stations on the air in most parts of the United States.

At that frequency, and even at those as much as 75 times lower, communication is normally limited to line-of-sight, or the horizon. And 249 miles is more than 160 miles beyond the horizon in the location used by Bill and Paul.

Also, there's the matter of power. Commercial UHF TV stations routinely use more than a million watts of power to send an acceptable signal 50 miles or less. Bill and Paul communicated over their record-breaking distance using less than 1 kW, the legal limit.

It all adds up to a most impressive achievement, especially when one remembers that it was accomplished by two amateurs using mostly home-built or modified surplus equipment. If the two southern gentlemen who accomplished it will excuse the expression, their feat stands as a notable example of modern yankee ingenuity.



(L-R) A4HHK and AD4HGN. Operating as W4HHK and WA4HGN on the amateur 2300 MHz Band, set a new tropo-scatter distance record on 11 July 1970, when a two-way contact was made between Bon Air, Tenn. and Collierville, Tenn., a distance of 249 statute miles.



Paul M. Wilson of Collierville, Tenn. stands beside the antenna used in his radio moon bounce experiment. Wilson is a member of the Third US Army Military Affiliate Radio System which provided most of the parts he modified in order to build his imposing radio station.

Aliens have to adopt the usual procedure when applying for an amateur license (submit an application to the general directorate). It will always depend on a decision in each individual

members of MARS plan to restore the building and undertake conversion work. A picture of the Zabbar Gate with members of MARS appeared recently in the "Malta Times."

blishment by it of a Hospitality Committee with the objective of providing visiting foreign licensed radio amateurs with an opportunity to meet some of our local active hams and if desired visit a local amateur station.

CROSSBAND RESULTS

WAR, NSS, NPG,and AIR had a combined total of 8,208 QSOs during the twelve hours and forty-five minutes devoted to the military-to-amateur crossband portion of the communication tests. Included in this total were 197 air/ground QSOs made by Navy aircraft on the east and west coast. Commemorative QSL cards have been mailed to all contacts that could be identified. Any amateur who has not received a QSL card confirming his contact should address a request for confirmation to the appropriate station, or Armed Forces Day Contest, Attention: Headquarters, U.S.Air Force, PRCOM, Room 5B531, The Pentagon, Washington, D. C. 20310. This request must include the amateur's call sign, the station worked, time of contact, and the frequency utilized by the military station.

73 GOES TO VIETNAM

The 43 MARS stations in Vietnam and Thailand are all getting copies of 73 now on a gratis basis through the efforts of Alex Scherer A9EU of Ottawa, Illinois. It is hoped that this amateur radio magazine will interest the many operators at these remote stations in getting on the ham bands and in pursuing amateur radio when they return to the U.S.

MERRY XMAS AND HAPPY NEW YEAR from WØCVU, Iowa's most truthful station. Generally on 20 meter SSB. Collins KWS-1 and 75A-4. Telrex Optimum spaced beams. WØCVU, Chas. W. Boegel, Jr., 1500 Center Point Road N. E., Cedar Rapids IA.

TR4 & AC3 just factory checked and alined. First Certified check for $450 winner. David Beckwith, W2Qm,M, Box 226, Pompton Lakes NJ 07442.

TECH MANUALS — R-390/URR, R-390A/URR, TS-186D/UP, BC-639A. R-274/FRR, OS-8C/U, $6.50 each; R-274/FRR, OS-8C/U, $6.50 each; TS-174/u, TS-175/U, TS-323/UR. $5.50 each. Hundreds more. S. Consalvo, 4905 Roanne Drive, Washington DC 20021.

HA-460 AND TR-108, both lightly used, $75 each, ppd. David Welty, 320 N. Blackstone, Tulare CA.

HAM-M ROTOR AND CONTROL, $94.95. Ideal Christmas gift for Dad. RG8U foam coax $.10 a foot FOB. Monte Southward, WB8GZQ, R1, Upper Sandusky OH 43351.

BUY, TRADE, SELL USED RECEIVERS, or trade for new general merchandise. Available HQ-200, 51S-1 SX-122 and BC-799B. 10-day money-back guarantee. 30-day warranty on parts and labor. Steven Kullmer, Evergreen Hatchery, Dysart, Iowa 51114.

FOR SALE EICO 720 xmtr — $45.00; Johnson 6N2 xmtr — $45.00; HA-1 Keyer w/VIBRO Keyer — $65.00;ARC-5 rcvr w/115 VAC p. s. — $20.00; Novice Xtals - $.75; Regency GT-523 mobile C' B' xcvrs — $35.00 each; EICO 221 VTVM — $20.00; AC-1 QRP xmtr — $20.00; P-2 SWR meter — $15.00. Need cash for graduate school. Will ship collect. R. O. Lust, WB9DWG, 320-4 North Tratt St., Whitewater, WI 53190.

TOLEDO MOBILE RADIO ASSOCIATION'S 16th ANNUAL HAMFEST AND AUCTION will be held February 21, 1971, Lucas County Recreation Center, Maumee, Ohio. $1.00 registration. Open table sales. Map and info write: TMRA W8HHF, Box 273, Toledo, Ohio 43601.

GREENE Center dipole insulator, with ... or ... without balun. See November issue 73, page 107.

SAROC, January 7-10, 1971, Flamingo Hotel Convention Center, Las Vegas, Nevada. Sponsored by Southern Nevada ARC, Inc., Box 73, Boulder City, Nevada. Advance registration +14.50 per person accepted until January 4, regular registration at door, includes Flamingo Hotel Late Show and drinks, Sunday breakfast, Cocktail parties, technical seminars and meetings, ARRL, DX, FM, MARS, QCWA, WCARS-7255, WPSS-3952 and WSSBA. Ladies program. Flamingo Hotel SAROC room rate $12.00 plus room tax, per night, single or double occupancy January 3 through 12, 1971. Mail accomodations request to Flamingo Hotel. Mail advance registration to SAROC, W7PRM, Club president. W7PBV, SAROC Convention chairman.

DRAGON FLY ... antenna, for 20-40-75 meters ... no traps ... no compromise ... eight months in development ... one feed line ... SWR one to one guaranteed. Construction drawings $5.00. Box 423, Wakefield RI 02880.

FOR SALE: Heathkit HW 32, $85.00; mint condition. M. Kaufman, 36 Harvard Ave., Brookline MA 02146.

MSI-DTL INTEGRATED CIRCUITS: Guaranteed new — gates $.56, F/F $.72, dual F/F $.92, MSI $2.00, dual Lamp drivers $1.60. Other inexpensive parts. Mitch-Lan Electronics Co., Dept. 7370, P. O. Box 4822, Panorama City CA 91412.

CAPACITORS. 100 MFD at 3 kv. Aerovox or Sprague, 6" x 8" x 14". Single terminal welded steel cans. 2 for $35.00, FOB. W5DAU. Box 1443, Hobbs NM 88240.

FOR SALE — MAKE OFFER: Gonset GSB-100, SSB XMTR; Hammarlund HQ-110C; Homebrew 800 watt linear. John McLean, 5603 N. 12th Ave. Phoenix, AZ 85013

FM CRYSTALS FM-210. They're accurate, by International. Transmit: 146 22, 146.25, 146.28, 146.31, 146.34, 146.46, 146.76, 146.94. Receive: 146.76, 146.88, 146.94. $5 each, singly or in lots. Wayne Green, 73 Magazine.

WEST COAST HAMS buy their gear from Amrad Supply Inc. Send for flyer. 1025 Harrison St., Oakland CA

but I did talk with several Californians who had worked him. I told them of my plight, and asked them to call me if they should hear him.

The next night when I heard someone mention his call, my hopes got up and I called in . . .but he had just left a few minutes before. Knowing he was around somewhere, I frantically searched the band that night, but absolutely nothing.

The fourth night my clock again went off at 1 a.m. Bear in mind that I would only have been asleep for an hour or so, and when the clock would go off, it would scare me half to death. Again I found a QSO where C21JW had just signed out to go look for a friend. I searched the band and found his friend, but no Nauru.

Again the fifth night . . .nothing. The sixth night, same story – and I was beginning to believe I had the Nauru curse.

On the seventh night, which was going to be my last try since he was due to leave in a day or so, and since there was no way in the world I could survive this ordeal any longer, I tuned the band for two hours . . .all in vain. Finally giving up, admitting that the Great White Father didn't have in his plan for W4BRE to work C21JW, I staggered off to bed.

I must have only been in bed for 10 minutes or so when the phone rang, scaring me out of my wits; it was phone band, when, forgetting that my amplifier was tuned up around 14.275, Blam! FUSES BLEW! OH NO! I've lost him. I've LOST NAURU. WE HAVEN'T YET EXCHANGED REPORTS.

If I thought I was panicked when 6FYC first phoned me, that was nothing compared with now. I WAS OUT OF MY MIND. Well, I must have set a world's speed record because when I got back on the air C21JW was telling me that he couldn't go to the phone band because he had to leave. Good enough, I was plenty happy just to get the contact.

WA6FYC and I moved up to the phone band, and I was thanking him . . .offering to send him money, my car, my house, anything in appreciation, and mopping the sweat off my brow, trying to regain a little composure, when "Break, Break, this is C21JW."

He had a change in plans, didn't have to leave just that minute, and came up and ragchewed with 6FYC and me for 30 minutes!

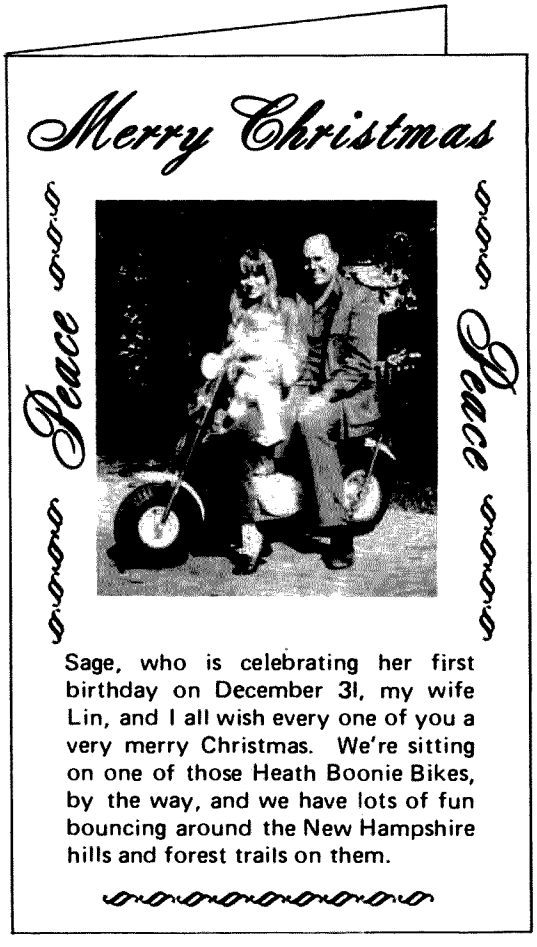
What an experience . . .I was dying to tell the people at the office and my other friends about it . . .but no one . . .absolutely no one but an honest-to-goodness true DXer could understand and appreciate this absolutely absurd, insane, and ridiculous undertaking, and why, after it was all over, I would say to myself . . .it was well worth it.

SELL HEATH DX-60A, 5 crystals. Used very little Guaranteed to be in good working condition. Make offer. Arris Sigle, 543 N. 2nd, Osborne, Kansas 67473.

VARIAC, 120 volt, 20 amp., uncased, new $25.00 each plus shipping (25 lbs. each). Brian Sherrett, TUSLOG, Dept. 6 Box 557, APO New York 09254.

TIRED OF "MICKEY MOUSE" TRANSCEIVERS? Immaculate KWS-1, 75A4 (.800 MHz, 2.1 MHz filters) all factory modifications. Coindel, Shure 444. Will demonstrate/guarantee. Top-notch, $1,000. (813) 646-5349, nights.

WANTED: Heathkit HA14 Linear Amplifier with or without tubes, HL9KQ American Embassy, APO San Francisco CA 96301.



Sage, who is celebrating her first birthday on December 31, my wife Lin, and I all wish every one of you a very merry Christmas. We're sitting on one of those Heath Boonie Bikes, by the way, and we have lots of fun bouncing around the New Hampshire hills and forest trails on them.

Director Green?

Many readers ask why I don't run for ARRL director since I know the organization so well and have proposed so many ways of improving it. Frankly, I somehow doubt that the executive committee would waive the bylaw prohibiting ham publishers from running for director, even though they have in the case of ARRL stalwart KØNL.

It would be nice to be able to run for the job and I think I could be a considerable help in bringing the League into the 1970s if I were elected. What, you ask, would I do as a director of the ARRL to improve that conservative old institution?

Better Directors

Probably the first thing I would do would be to try to encourage amateurs to run for director in other divisions of the ARRL who are interested in improving amateur radio to replace those directors who are there for the prestige of the office rather than as true representatives of their constituents. Little can be done to improve the League until at least nine of the 16 directors want to improve it. Right now it seems hopeless.

Sound Financial Basis

There is no excuse for the League losing money every year! There are many ways to increase income and to cut expenses. By reducing the size of QST by a fraction of an inch so it would fit on modern web offset presses and by using more modern paper a saving of thousands of dollars a month can be achieved. There are many other areas where substantial savings can be made without losing any valuable services. We can see that the League investments are bringing in a maximum return. We can plan ahead for continued nonprofit operation, but an eventual end to the tax-free status.

Washington Lobby

Only when the ARRL has a registered lobby in Washington can it truthfully say that it represents amateur radio. Such a lobby would put an end to the doubletalk excuses from HQ and would give amateur radio the first real opportunity to protect itself in Washington. A monthly newsletter to congress would be invaluable in laying the groundwork for a lobby. Amateurs are making news all over the world, but few outside of our hobby hear about it. We need to beat our drum. It is entirely possible that much or all of the cost of a lobby in Washington could be financed entirely separate from the ARRL, thus keeping League expenses down.

Emerging Nations

The key to the future of amateur radio lies entirely with the votes of member nations of the International Telecommunications Union at Geneva. It would behoove us to keep this in mind and devote some time and energy towards protecting our frequencies internationally. The ITU is presently controlled by the emerging nations of Africa and Asia and the League could be of great help to many of these countries at little cost. It could offer custom-made amateur radio regulations for individual countries, complete with amateur license exams. It could organize expeditions to these countries to explain the value of amateur radio to the heads of the countries and their top officials. Club stations could be organized in the countries, probably in high schools. If equipment is not available it could be arranged to be donated by interested amateurs and manufacturers. Every effort should be made to assure amateur radio votes at the ITU.

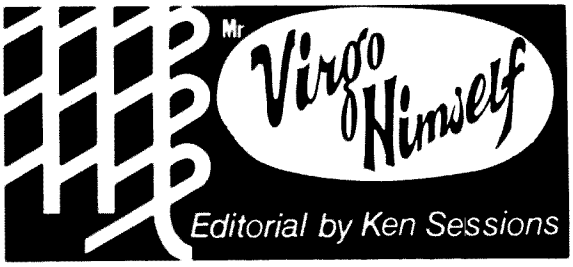
A Modern QST

The club magazine would interest many more amateurs if it were written in a warmer and more friendly tone. It would look more like 1970 with modern type and better layout design. Readers might have more confidence in the League if both sides of controversial problems were openly discussed in QST. Some of the departments which fill up so much of the space in QST could be shortened or eliminated in the interests of bringing information of interest to the most readers.

Directors Meetings

The inability of management to get decisions from the directors more than once a year has

(cont. on p. 102)



Last Chance for SAROC Flight!

From early indications, the upcoming "fun" convention in Las Vegas (January 1971) will be the biggest success of any ham convention ever held anywhere – bar none. If you've got a vacation coming, or if you would just like to take the wife and get away for a weekend, by all means attend! Even if your wife doesn't like conventions, she'll want to go to this one – because Las Vegas is a magicland – probably the only place in the world where you routinely bump into TV personalities, movie stars, and other famous personages. (Last year I poked Don Rickles with a Motorola telescoping antenna.)

If you're planning a West Coast vacation anyway, here's your chance to be really sneaky. You can fly on one of SAROC's two chartered "champagne" planes (from New York or Chicago), stay a full 3-night weekend at the Flamingo, enjoy a couple of stage shows, and buddy it up with hams from everywhere – all for less than conventional airline rates.

As if that weren't enough, additional free "flings" are being sponsored by public-spirited groups and organizations. For example, Ham Radio magazine is footing the bill for an all-you-can-drink cocktail party on Thursday night; the next evening, Swan Electronics is picking up the tab for the same kind of arrangement. And the FM boys in Las Vegas are planning a head-busting three-night open house, with free hard, soft, and hot stuff to drink.

The round-trip "everything included" plane fare from New York is $229 (from Chicago, it's $199), and there's a full-page ad in this issue that tells exactly all that the price includes. But the ad doesn't tell you that SAROC is *the* Western convention, where the accent is on fun and the emphasis is on ham radio. This January will mark the Sixth Annual Radio Operators Convention and the fourth (and by far the biggest and best) national FM convention.

With the August FM lineup (practically all the big names in repeaters) and the unprecedented current popularity of VHF FM, a turnout of more than a thousand FM'ers is expected. This, coupled with the already well established popularity of the other aspects of SAROC, should make it a convention to top all others in ham history.

If you're going, better make plans now. If you don't reserve a seat on one of the charter flights before November 25, you'll have to get there under your own steam – and that could get expensive.

Discrimination. . .

Wayne Green used to mention occasionally that the League wouldn't let him speak at this convention or that – that the League wouldn't let him set up a booth for 73 at various League-sponsored affairs, and other seemingly unfriendly or discriminatory actions on the part of the ARRL. To be quite blunt, I only half-believed him because his charges all seemed to be so fantastic.

But at the recent Boston convention, I found out for myself. I was invited to speak on repeaters, and accepted. But the League said no. I saw a letter Huntoon had written saying that I wasn't fit to speak at any League convention.

A few of the fellows protested to the League, even to the extent of offering mild threats of "breaking off" with ARRL affiliation. But Robert York Chapman, New England Division's director, answered one of the protestors with a counterthreat. It is never too late, he said, for the League to back out of backing the convention. Clearly, the convention planners had to make a choice between the League and the staff of 73.

Working almost surreptitiously, but closely with the convention planners, 73 rented an auditorium in the hotel where the convention was being staged, then held its own programs with its own speakers. And the whole thing went off extremely well.

The next convention was Tarrytown, another League-sponsored affair taking place within the Hudson division. I suggested to Wayne that we set up a booth there.

"Go ahead and try," Wayne told me. "But I can tell you now that they'll tell you their booth space has already been sold out."

Well, I tried anyway. I contacted Harry Dannals, who told me in a very friendly and congenial manner that there would never be any space for 73 in any convention that he is involved with.

Now, fellow readers, I have just told you the truth. There is not one ounce of exaggeration in the foregoing. And if Harry Dannals is an honest man, he will certainly admit that what transpired between us was exactly as I have related.

I charge Harry Dannals with discriminatory practices, and I charge the ARRL with sanctioning such practices. I don't want to make an enemy of Dannals, because, quite frankly, he is a personable and congenial fellow. But he must learn that his acts are not those of a responsible director.

Those of you in the Hudson division who agree with me could probably carry a great deal of weight if you'd drop Harry a line letting him know how you feel.

. . .K6MVH/1■

Ed. Note:
Last month (or the month before), Raving Dave took on the Technicians in the country, and after three rounds went down for the count. This month, as "Dave the Brave," it's Conditionals. Watch for his subsequent attacks on Novices, premarital sex, Mexican food, the electoral college, and motherhood.



In previous issues I have mentioned phone patches, usually Latin-American in origin, which have been QRM'ing the DX frequencies, especially the low end of the 20 meter phone band, in ever growing numbers. The response of the readership has not been particularly encouraging; there seems to be a feeling that nothing can be done about the situation because, in the words of one of my correspondents, ". . .foreign operations cannot be regulated or controlled." While this is partially true, let me assure you that it is not completely impossible to effect changes. There is no basis for the total frustration which has been expressed.

There are certain actions which can be taken that may prove to be effective; for example, a large percentage of these patches are being run by stations in Florida and Puerto Rico, both of which are indeed subject to the regulations of our own licensing authority. The FCC – while many U.S. hams may consider it unsympathetic to the needs and desires of the amateur fraternity – is quite responsive and sensitive to reasonable requests, *when they are made in a responsible and constructive manner.* It is far from an impossibility to envision the establishment of an officially designated frequency allocation which would limit the patches to sequestered portions, as is presently done with RTTY, thus going a long way toward eliminating the annoyance.

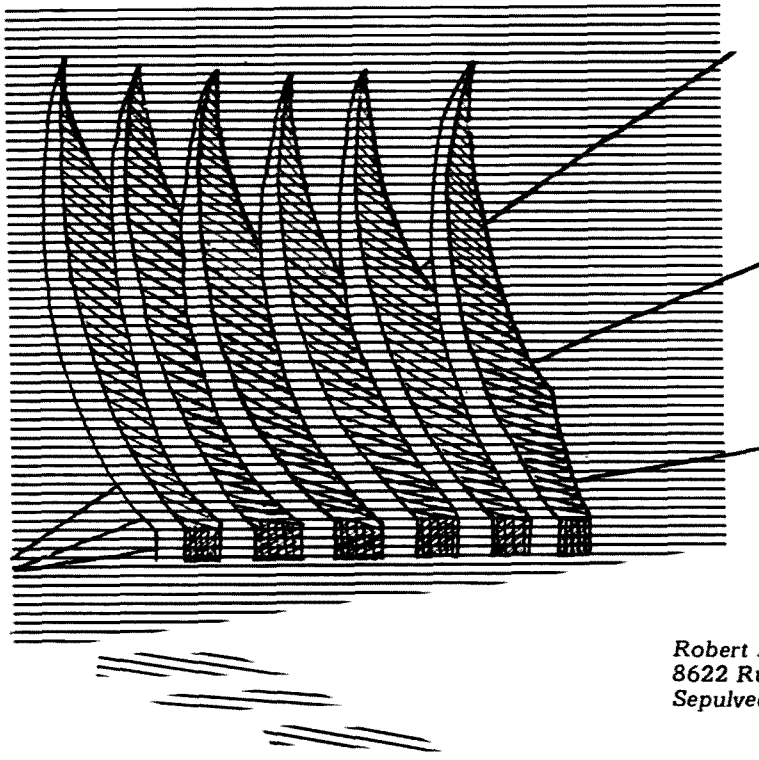
But there is another side to this coin. The phone patch stations are also entitled to a fair measure of consideration. There is no foundation, either in the regulations or by operating precedent, for DX'ers to feel that they are entitled to a preemptive "lock" on those portions of the bands which they regard as desirable, and that they are perforce within their rights in bludgeoning the opposition into submission by their sheer weight of numbers, by using power amplifiers, extravagant antenna systems, or by any other means. There is still a right and wrong, after all.

The problem is a knotty one. Both groups have raised legitimate complaints. Both have valid grievances. And somewhere along the line, accommodations must be found so as to create order out of chaos.

A tangential point is being raised by the General class operators. Many DX stations seem to restrict their listening frequencies solely to our U.S. Advanced and Extra class subbands, making it virtually impossible for the Generals to compete for DX on an equitable basis. Of course, it must be acknowledged that it is awfully simple for anyone to master the relatively elementary material covered in the single examination element which upgrades them to the Advanced class. Anyone who is at all serious about working DX would be more than willing to devote a small portion of his time toward accomplishing this simple task.

The Conditional class ham, however, is faced with a genuine crisis. He must qualify in all elements, both CW and theory . . .is given absolutely no credit for any elements in any of the exams . . .hence must pass the 13 wpm code test plus the General and Advanced theory elements. Many of us are prone to forget that there are vast numbers of people who hold this grade. If you will examine the figures (they may be found in recent issues of the callbook), you will learn that of the total ham population, more than 10% fall into this category. There are 10 states in which Conditionals outnumber Generals! In a few of these states the examination points are truly beyond a reasonably convenient traveling radius. But in several of the states referred to, this is not the case, and I fear that the Conditional ticket has been acquired under terms which could not be regarded as completely justified by the circumstances. The regulations have been applied, in all too many instances, to circumvent the qualifying requirements, and some persons who could easily be expected to get to the examination points have simply exaggerated the hardship angle of the physical infirmity excuse. I am personally acquainted with several self-styled "invalids" who eat like horses, work like mules, and climb up and over ridges like mountain goats during the deer

(cont. on p. 104)



SOLID STATE EXCITER

Robert E. Bloom W6YUY
8622 Rubio Avenue
Sepulveda CA 91343

My original thoughts about undertaking a design project of this magnitude were brought about through a challenge by W6EGZ, after having just completed a three-year design of a solid-state receiver. This was early in 1966. Based upon the complexity of the receiver it was anticipated that about one year would be required to complete the transmitter. This would mean using all available evenings and weekends, abandoning all on-the-air operation and all other aspects of ham radio. As with the receiver, it took a similar three-year period.

The big hangup in progress was encountered in designing a satisfactory third-mixer stage, free of parasitics. I tried many mixer configurations initially without success.

It wasn't until the advent of a magical "black box" concept that appeared on the industrial electronic market, cloaked in secrecy and at a price of just under $200 that progress once again was under way. This started a frantic search for literature and information as to how this thing called a "double-balanced mixer" was operated. I say "magical" as this circuitry is so versatile that it can be used as a phase detector, frequency doubler, current-controlled attenuator, balanced modulator, pulse modulator, phase detector, etc. But let's start at the beginning.

Were it not for the availability of all commercial test equipment this project would not have been attempted. Such items as a Hewlett-Packard counter, generators, and meters; Tektronix oscilloscopes; Measurement Q meter and grid dip oscillators; temperature-controlled oven; sheet-metal cutting and bending equipment; and a Heliarc welder were some of the items used. For those who wish to duplicate all or part of this system, all pertinent dc and signal voltages are called out and all pertinent coil data can be found listed in Table I. All circuits other than the bulk elements of the power supply and the final are of modular construction; in today's technology of miniature construction this is the easiest and neatest, and lends itself readily to circuit change.

The individual circuits were first breadboarded, checked out, and then made into modules using single-sided 5/16 in. copper-

Table I. Coil and Transformer Data.

Coil or Trans. Identif.	Core Material	Primary Turns	Secondary Turns	Tap from bottom	Wire type	Notes	Transmitter Stage
T	Ferrox-Cube cup core 1811P A100–3D3	80 (700 μH)	16		Pri. 7/41 Sec. 15/41	Unloaded "Q" 280 Resonant at 453 kHz with 170 pF	Balanced modulator
T1	Ferrox-Cube cup core 1408P A100–3D3	70 (500 μH)		7	7/41 Litz.	"Q" Unl. 230	453 kHz LF ampl.
T2	Ferrox-Cube cup core 1408P A-40-4C4	30 (40 μH)	2	4	30/44 Litz.	"Q" Unl. 170	1st mixer 2045 kHz
T3	Powdered-iron slug-tuned ceramic form ¼" dia both coils	40		5¾	7/44 Litz.	"Q" Unl. 55 "Q" Loaded 5	Broad-band, 2nd mixer
T4	Ferrox-Cube toroid 266T-125-4C4	13 Trifilar	13 26 total wound		26 solid Teflon cov.	Sec tap is the end of one winding & start of another.	Double-balanced mixer
T5	Ferrox-Cube toroid 266T-125-4C4	9 Trifilar	8 wound		26 solid Teflon cov.	Pri tap is the end of one 9-turn winding & start of other 9-turn winding.	Double-balanced mixer
L6	Powdered-iron slug-tuned ceramic ¼" dia	25			28 solid enameled	Trim with 8–35 pF miniature trimmer & fixed 75 pF silv mica capacitors	7.0 MHz transistor rf ampl
	3/8" ceramic, brass, slug-tuned	10½			24 solid enameled	No trimmer	14.0 MHz
	Powdered-iron slug-tuned ¼" ceramic form	11¼			26 solid enameled	Trim with 8–35 pF miniature trimmer	21 MHz
	Powdered-iron slug-tuned ¼" ceramic form	10			20 solid enameled	No trimmer	28.0 MHz
L7	Powdered-iron slug-tuned ¼" ceramic form	15		2¾ & 9 turns	26 solid enameled		Band selection osc 3rd mixer
T8	Ferrox-Cube cup core 1408P A-40-4C4	50	2		Pri 32 Sec 28	Resonant with 22 pF silver mica at 24.5 MHz	1st mixer, oscillator
T9	Powdered-iron slug-tuned 3/8" ceramic	80	20	Pri 24 Sec 9 & 15	32 solid enameled	See text	Vfo output transformer
L10	Powdered-iron slug-tuned ¼" ceramic form	25			28 solid enameled	Trim with 8–35 pF miniature trimmer & 75 pF fix. silv mica	12BY7 driver plate, 7 MHz
	Brass, slug-tuned 3/8" ceramic form	15			24 solid enameled	Trim with 7–25 pF miniature trimmer	12BY7 driver plate, 14 MHz
	Brass, slug-tuned 3/8" ceramic form	10			26 solid enameled	Trim with 8–35 pF miniature trimmer	12BY7 driver plate, 21 MHz
	Powdered-iron slug-tuned ¼" ceramic form	9			20 solid enameled	Resonate with 10 pF fixed silver mica	12BY7 driver plate, 28 MHz
L11	2" dia AirDux 1606T coil stock	15		3&8	14 plated	Tune with 200 pF 2 kV split-stator, Johnson 200FD20/ 155-505 C-11 midget air-tuned 300 pF (Hammarlund MC-325-M)	Multiband coupler, final

clad board. (Printed circuits could have been used; however, the construction about to be described was preferred as it lends itself to change where printed circuitry does not.)

It was first necessary to redraw the schematics, keeping all symbols to actual size and positioned exactly as they would appear on the finished board (according to the overall block diagram, Fig. 1). A dot

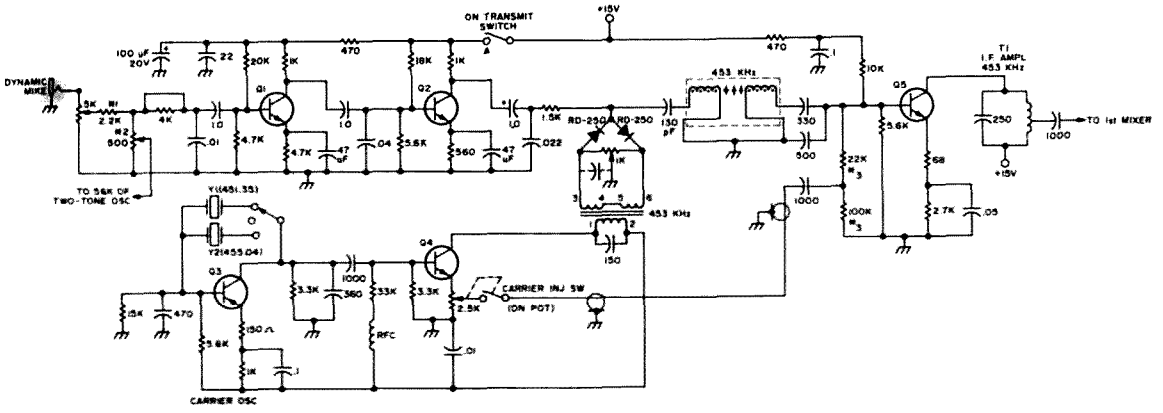


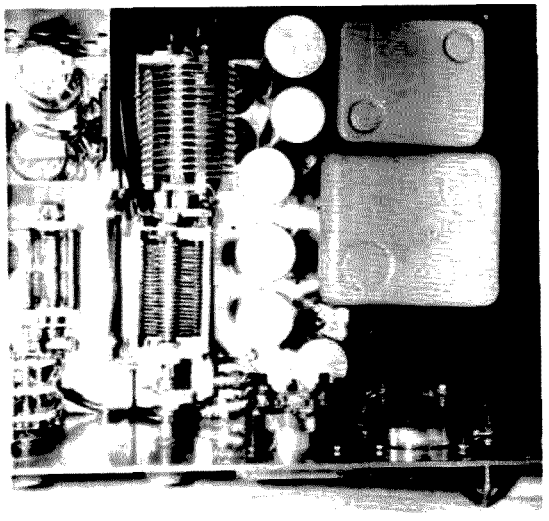
Fig. 3. Audio, balanced modulator, mechanical filter, i-f amplifier, carrier oscillator, and carrier buffer amplifier.

for linearity monitoring and testing. The mechanical filter is one of the higher quality Collins multi-element 3.1 kHz variety with steep skirts down to 90 dB. The input is series tuned while the output is series-parallel tuned using capacitors in a divider configuration. The loss introduced by the filter is only 9 dB and the gain of the following i-f amplifier had to be severely limited by tapping the coil of T1 near the bottom end and inserting degeneration in the emitter of Q5.

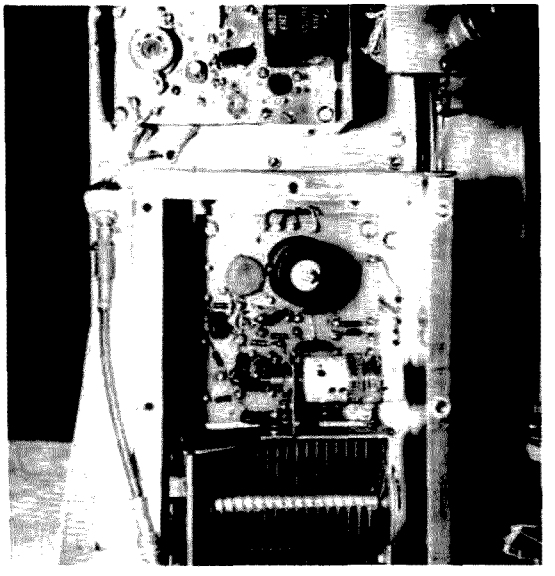
Overall gain measurements for this board were made using a 10/1 divider scope probe connected at the collector Q4 of the i-f amplifier. Using a single tone signal and no carrier, the 500Ω pot in the audio amplifier input circuit is set for a 2.5V p-p indication measured at the base of Q1. Inserting carrier to produce a 100% modulated sideband signal, the amplitude will increase to 4.8V p-p. Turning off the carrier and switching to a two-tone audio signal the indication will be 3.8V p-p.

The next board, which is located in the lower left-hand corner on the bottom of the chassis, contains the 2045 kHz first mixer and 2.5 kHz crystal oscillator. The major problem encountered with this stage was in designing a mixer transformer, T2, with a Q high enough to reject the 2.5 kHz oscillator signal from its output. This was finally accomplished using the core material and data as furnished in Table I.

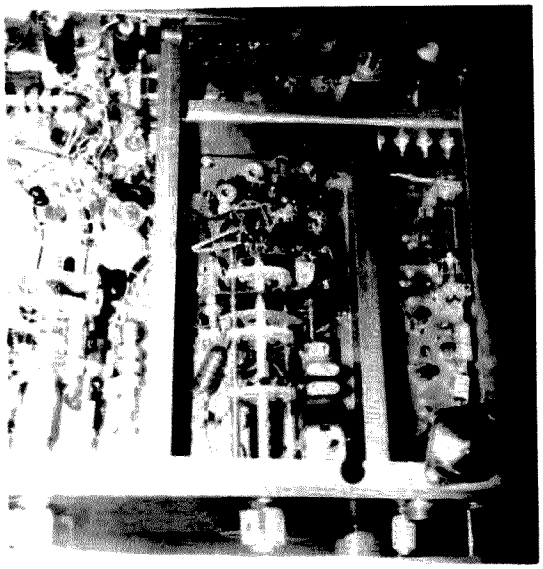
The 1.8 kΩ series resistor from the 453 kHz i-f to the base of the second mixer was selected to limit the signal to the mixer. With a two-tone signal, the mixer output amplitude at the collector of Q6 is 1.9V p-p. A voltage divider network consisting



Power supplies and complete final amplifier.



Vfo with lid removed; also shows selectable sideband crystals and balanced modulator.



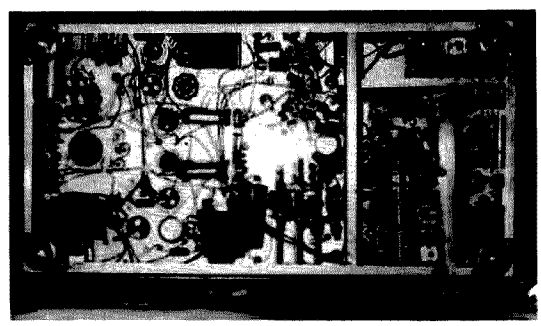
Left — band select switch and 6146 sockets. Middle — band select crystal oscillators, 2nd and 3rd mixers, and rf amplifier. Right — Mike amplifier, mechanical filter, and i-f amplifier. Back — 2.5 MHz crystal oscillator and 1st mixer; two-tone oscillator.

of a 220 and a 150Ω resistor shunts the secondary of T2, setting the first mixer output signal level at 300 mV p-p. This measurement is made with transistor Q7 removed from its socket. A voltage dividing network optimizes the 2.5 kHz oscillator signal to the mixer T8, limiting the drive to 550 mV p-p. Both T2 and T8 coil data is critical and is listed in the coil data chart, Table I.

In the chassis compartment just to the right of the audio and 453 kHz board are a total of 3 modules. Toward the panel is the band selector crystal oscillator stages, Q14 and Q15. To the rear of the band selector is the broad band second mixer Q7 and emitter follower Q8. Mounted on top of this board is the third mixer, the double balanced mixer using the latest techniques, and the rf amplifier Q10.

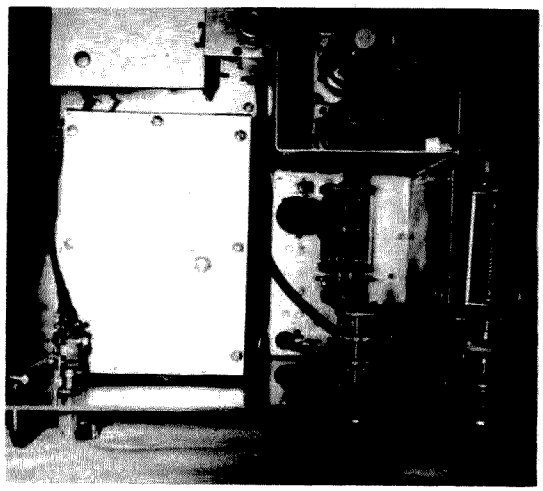
The second mixer has a fixed frequency input of 2045 kHz and a vfo input of 2900–3550 kHz, making the usable output frequencies 4945–5595 kHz. The problem encountered here was to develop a coupling circuit with a flat response over 650 kHz. The coils were wound on ¼ in. ceramic slug tuned forms, resistive loaded to a Q of about 5. The coils are spaced ¾ in. on centers. The coupling capacitor value is very critical; the calculated value is 10 pF but in practice optimized out at 8pF. The circuit has a frequency response flat to better than 2 dB. Coil data can be found in Table I. Unloaded Q of each coil is about 55. The collector Q7 is tuned for the low frequency end of the bandpass while the emitter of Q8 is tuned for the high end.

T4 and T5 are wound on 4C4 ferrite toroids, 3/8 in. diameter. Ferrox cube 266T125 or equivalent may be used. I must have wound 40 coils of four different diameters and ½ doz. materials before coming up with a final design. Most of the materials tried seemed satisfactory except for the problem of driving their low input impedance. The key was to select a material with high enough permeability to obtain an input of something over 50Ω using a small number of turns and setting the emitter follower current to 10 or 15 mA. All of the information I received from engineering contacts advised designing both input and output coils with identical number of turns but I found this only to be true if a very wide frequency range was desired.



Bottom view of power supply and final amplifier.

My final design emerged with coils T4 and T5 with 13 and 9 turns respectively. These coils must be trifilar wound. It is recommended that the three lengths of 26-gage wire be of different color so that they may be easily identified. This is not an absolute necessity as identification can be made using a continuity meter. Twist the three lengths of wire around each other and then wind onto the toroid cores, spacing the turns evenly over the entire circumference and then tacking into place



Vfo, 12BY7 driver, 6146s, tuning capacitor for 3rd mixer and driver, and function switch.

using a small quantity of Polystyrene cement. Use the cement sparingly as the capacity effect is critical.

Actually, the mixer has a bandpass much wider than needed – possibly as great as 200 MHz – and should the cement spoil the higher frequency end, you will never know it as frequency interest ceases beyond 30 MHz.

The diodes used in the balanced mixer are Hewlett-Packard Schottky hot carrier type 2900. The type 2800 was found equally good. Experiments with 1N269, 1N270, and 1N277 types were found to operate satisfactorily in this frequency range also. The driving signal level into transformer T4 is 700 mV (p-p) and is measured using a two-tone audio signal source with no carrier inserted. Examination of the schematic for the balanced mixer and rf amplifier (Fig. 4) reveals many components, yet all are contained on a board 1¾ x 1½ in.

The only other circuits in this compartment are the band selector oscillator module and coil switch assembly. The rf coils are mounted on a metal disk-shape shield which is assembled as part of the bandswitch. (See ARRL sideband manual, page 66 for ideas on this subject.) Both the rf amplifier and the 12BY7 driver stages are panel-tuned by a miniature 8–108 pF two-gang capacitor. The tuning knob for this is located just to the left of center on the panel.

The function selector switch (Fig. 5) is also panel mounted. This allows selection of operate, zero-beat, CW, single-tone test, and two-tone test. The problem posed by the band selector stage (Fig. 6) was in obtaining an equal output amplitude from each crystal. This section had over three designs before the final one. This may not have been a problem at all if similar type crystals had been used but it turned out for the best since the selection of crystal types ceases to be critical. It is to be noted that for 80 and 20 meter operation the same 9 MHz crystal would be used. Although the final will tune from 80 through 10 meters, no coils were made for the rf amplifier and driver stages for the 80 meter band. Switch

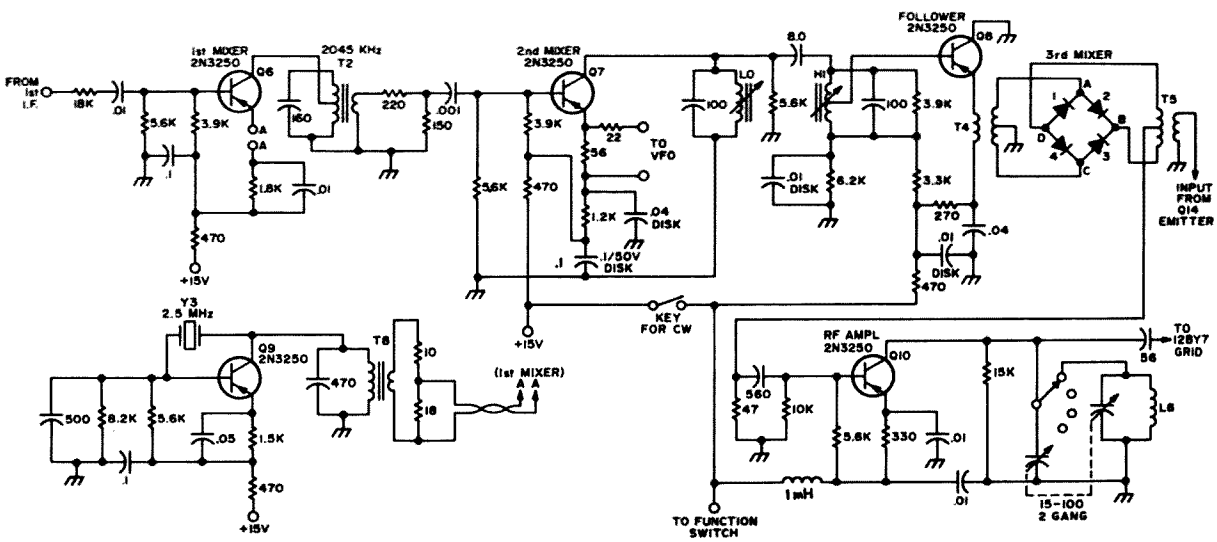


Fig. 4. Balanced mixer and rf amplifier.

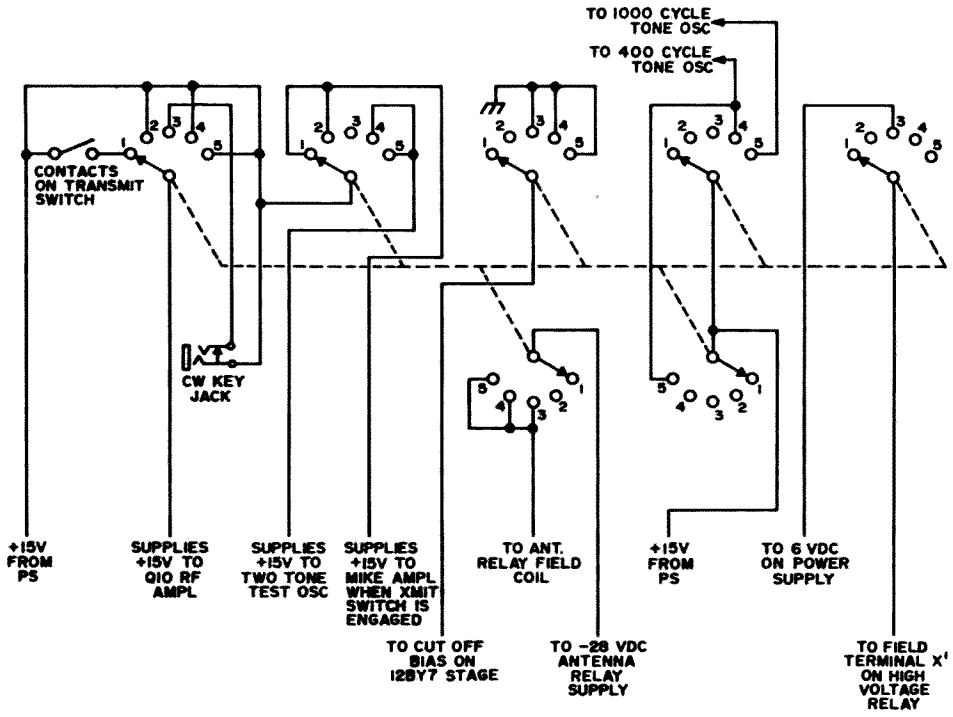


Fig. 5. Function switch.

positions are provided and 80 meter coils can be incorporated at a later date if desired.

Because of the 650 MHz maximum frequency coverage of the vfo it will require three crystals to completely cover the 10 meter band. A 23 MHz crystal covering 27.945–28.595, a 23.6 MHz crystal covering 28.545–29.195 and 24.2 MHz for 29.145–29.795. Other combinations can be used of course. In that these cannot be switched, one must decide what third of the band is desired at a time, changing crystals in order to move to any other third of the band. It would be possible to design a board and switching arrangement containing all crystals, making it possible to switch to any portion. My interests in this band do not go to this extent and I am satisfied to pick mine a third at a time.

The largest board on the bottom of the chassis is the one containing the mike amplifier, mechanical filter and i-f amplifier 6 x 1¾ in. Actually the entire exciter portion takes up only one third of the chassis space.

The vfo module is contained in its own shielded box and is located on top of the chassis and in front of the box containing the crystal carrier oscillator, buffer, and balanced modulator. Incidentally, these two modules were completed about a year before other modules of the transmitter, including construction of the basic chassis.

The vfo (Fig. 7) was designed using a tuning capacitor out of an ARC-5. As you know, this capacitor is considered as fine in quality and stability as any obtainable. The oscillator coil is wound on a ribbed ceramic form ¾ in. in diameter. The big problem with this stage was developing a pure sine

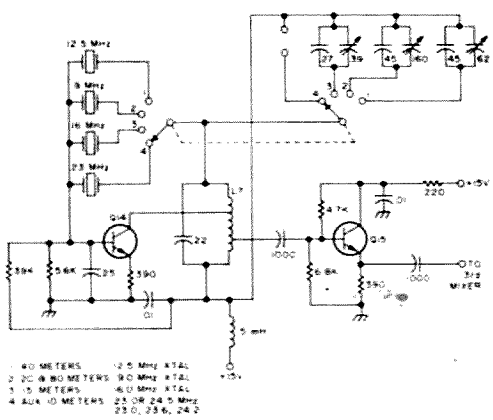


Fig. 6. Fixed crystal oscillator to third mixer (double-balanced mixer).

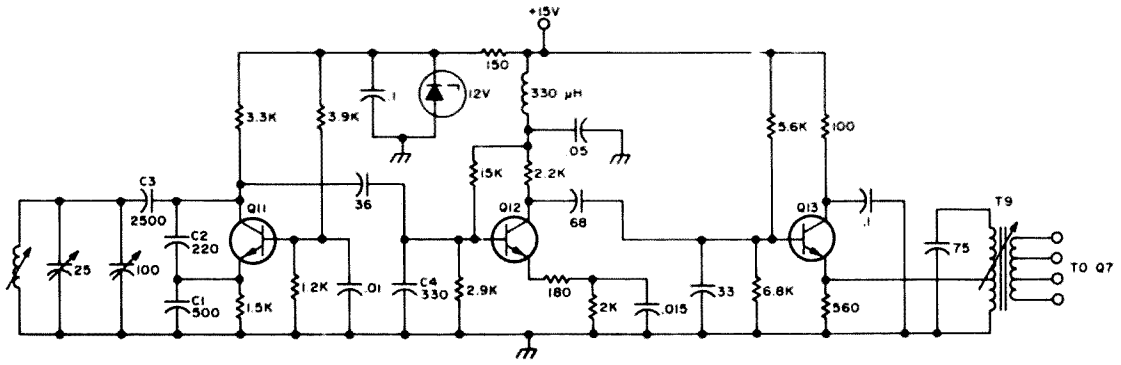


Fig. 7. Variable frequency oscillator (2.9–3.55 kHz).

wave (undistorted) rf output signal across the band. This was finally obtained after designing an amplifier (Q12) and emitter follower (Q13) that reduced the loading on the tunable oscillator.

An HP counter and temperature-controlled oven were used for the process of stabilizing the oscillator. Critical components are C1, C2, and C3. C1 and C3 are silver mica dogbones while C2 comprises four separate capacitors (2 ea. 68 pF N-750s, a 21 pF N-330, and a 63 pF NPO all in parallel). Looking back over my data, the temperature tests were run for over two weeks. Frequency drift is 11 Hz for a change of 25°F over the vfo frequency range of 2.9–3.5 kHz. Once this module was completed, the unit was closed completely and not opened again until pictures were recently taken of the entire transmitter. At that time, only the top cover was removed.

At the time this unit was designed I did not know what output voltage would be required to drive the second mixer as plans for this stage were still quite a way down the road. Hence, a multitapped coil with output from 1.0 to 2.5V p-p was made. This turned out to be a bad guess as the output from the lowest tap was more than optimum. Rather than go back and redesign the coil (T9), a 22Ω series resistor to the emitter of Q7 was incorporated, thus optimizing the second mixer for the best output waveshape. It is suggested that anyone duplicating this design use a secondary winding on the 3/8 in. diameter ceramic slug-tuned T9 form of 12 turns tapped at 4 and 8 turns, rather than the information as given in the coil table. No series resistor is needed if this winding data is used.

The two-tone oscillator (Fig. 8) is located in the same compartment with the 2.5 MHz oscillator and buffer module and is mounted to the back side of the chassis in a vertical position.

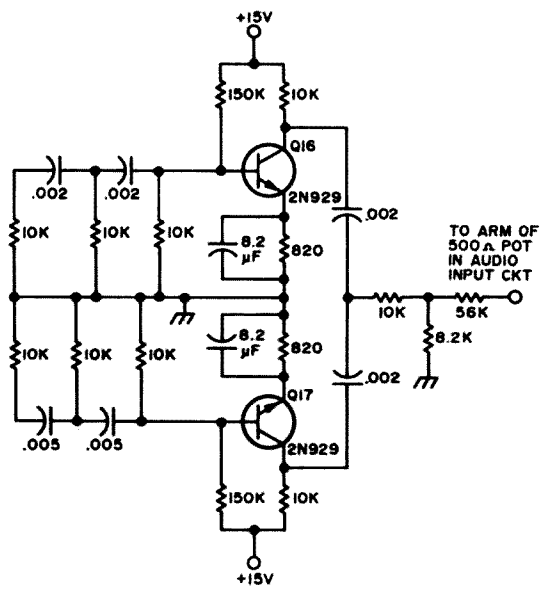


Fig. 8. Two-tone oscillator schematic.

The vswr indicator circuit was constructed so that all components could be mounted in the space below the rf tuning capacitor. The right-hand portion of the chassis contains the regulated power supplies (Fig. 9). A module containing all of the rectifier diodes as well as the complete

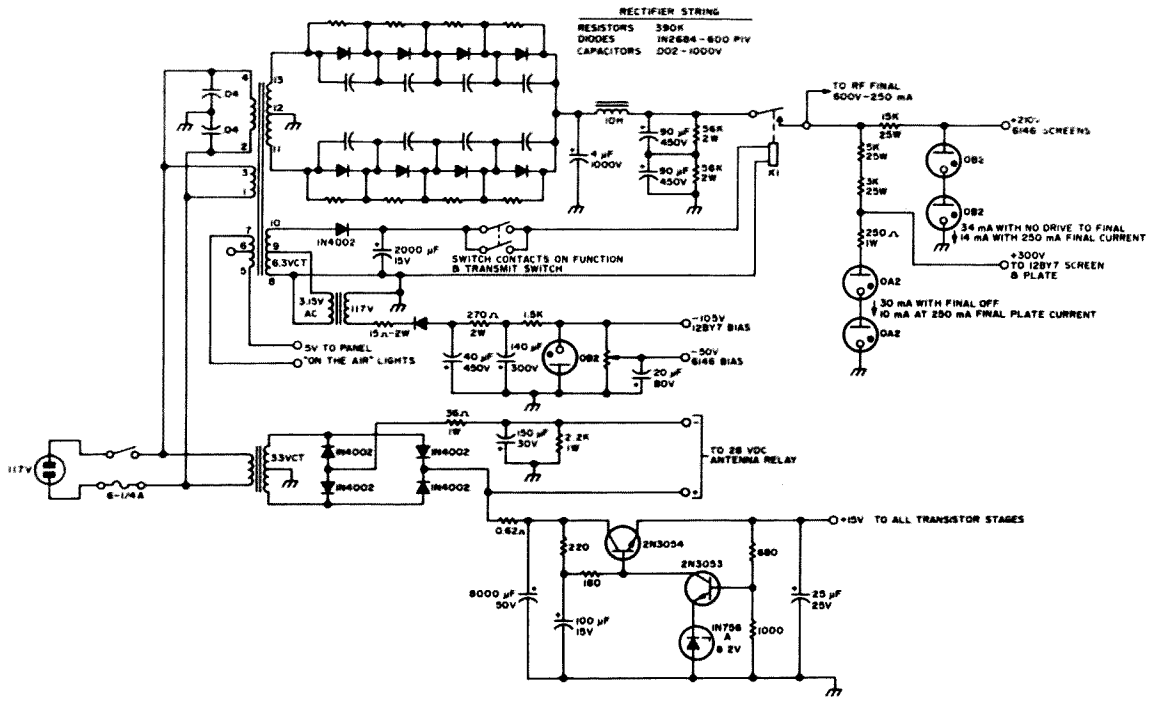


Fig. 9. Power supplies for SSB transmitter.

component circuitry for the low-voltage and antenna relay supply mounts on the side of the chassis.

The high-voltage transformer is hermetically sealed, containing three centertapped secondary windings. The 6.3V winding serves three functions: furnishes the 6.3V needed for tube heaters, it operates the high-voltage relay, and it furnishes 3.15V primary power to operate a separate transformer for the bias supply. The high-voltage rectifier string is made up of 8 1N2684, 600 PIV diodes, each shunted with 390 kΩ resistors and 0.002 mF (1 kV) capacitors for transient suppression.

The ac. line switch has a configuration that turns on the low voltage dc supply in its center position and adds line power to the high-voltage supply in its up position. The function switch is a three-deck, five-position, seven-circuit affair made up from an Oak switch kit.

Function Selector

Function positions are as follows; Sideband, tune, CW, single-tone, and two-tone. Positions 1 and 2 are similar except that in position 1 there is no supply voltage on the third mixer until the transmit switch is activated. In position 2, voltage is supplied to the mixer and by inserting carrier; the vfo can be set to zero beat in the receiver at the desired frequency. This condition is not desired on position 1 as it may interfere with the reception of the station being worked.

In the CW position, voltage is removed from the audio stages, and B+ is supplied to the driver and final. The telegraph key interrupts B+ to both the second and third mixers as well as the transistor rf amplifier stages. Positions 4 and 5 provide voltage to one or both of the tone generators, respectively.

The transmit switch is the multileaved telephone switchboard type, and in the transmit mode controls the following: cuts the bias voltage to the 12BY7 driver, energizes the high-voltage and antenna relays, supplies voltage to the audio amplifier and third mixer, and switches the *standby* and *on the air* panel lights.

. . . W6YUY ■

Solid-State Control for SSB Exciters

E. Dustin W4NVK
571 Orange Ave W
Melbourne FL 32901

The conventional approach to solving the critical problem of tuning a sideband receiver is to use lots of bandspread and a very good mechanical knob linkage to give very fine tuning adjustment capability with little backlash. Sometimes, though, even the best knobs get jerky and develop some backlash after a hundred hours use or so. The only difference between very good knobs and not-so-good knobs is the amount of this jerkiness.

To forever remove this backlash problem and give you a degree of tuning fineness such as no mechanical dial can approach, you need only add a simple diode variable capacitor for precision frequency shifting, or "delta frequency" control.

The best amount of delta frequency ($\triangle f$) for amateur use appears to lie between 200 and 400 Hz. The fellows with separate transmit and receive controls have an awful time staying on frequency in a roundtable, and I frequently have to shift the full 400 Hz from the operating frequency to reach the worst of them. This control is especially necessary to tune in a feminine voice, since the exactness of tuning SSB gets very critical as the voice pitch gets higher. I have never been able to get clear reception on female ops with my mechanical dial, but with the vernier $\triangle f$ there is one critical frequency where their voices clear up noticeably.

This control is a must for the serious phone-patch operator, too, since hams who develop a facility for understanding a highly garbled SSB voice forget that the layman does not have this tolerance, and can't understand even a slightly garbled voice. In receiving an off-tune patch, they will be polite, but they may be, in reality, missing much of it.

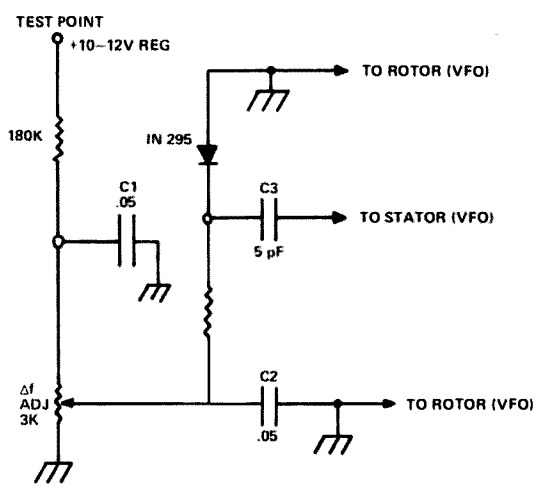
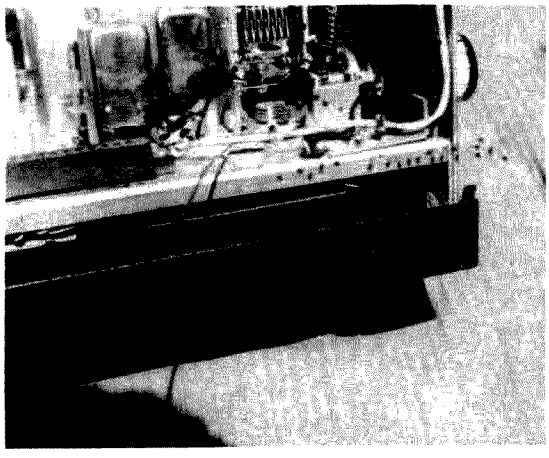


Fig. 1. Schematic diagram of "delta frequency" vernier control for SSB receivers.

This critical nature of SSB has to do with the harmonics and overtones of the voice, all being shifted the same number of hertz instead of being shifted the same percentage of frequency. You who have tape recorders are probably aware of the fact that the voice doesn't appear to suffer much if the tape speed is slightly wrong, although music does protest some. With the same degree of error in frequencies, applied as a frequency offset (which is the same number of hertz regardless of frequency), even voices become seriously garbled, and music comes out as total nonsense. If you doubt how critical this is, try to tune in music on one of the foreign BC stations with your sound just right until you get zero frequency error and the proper phase, within about 90 degrees of the station carrier. Even with this vernier control, you won't find it easy to tune to music, since a phase-lock receiver and residual carrier must be used to get phone company quality out of SSB.

The circuit for the $\triangle f$ control is shown in Fig. 1. As indicated, the only adjustment device added to the existing receiver is the tuning pot, which can be mounted anywhere you please. A shielded line of a three-wire twisted line can feed it. Since only dc is present on these lines, their length is of no consequence. However, this is a moderately high impedance circuit of up to about 3 kΩ, so keep the pot leads



The entire circuit can be placed neatly within the existing space of most transceivers. This photo shows the components mounted near the vfo capacitor in a Galaxy.

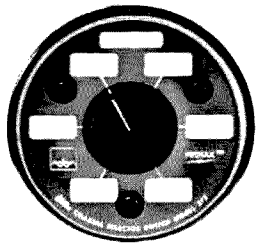
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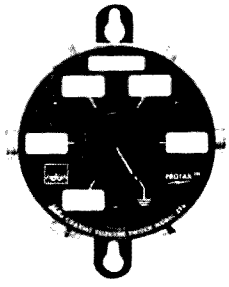
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away from ac lines or you might induce enough ac to FM your vfo a small amount.

Placement of parts is not critical, but keep the components attached to the vfo tuning capacitor rigid, or the whole thing will be microphonic. Keeping reasonably short leads on the components will accomplish this objective just fine.

The pot I used was a used 3 kΩ TV pot. I drilled a 3/8 in. hole in the front panel, and mounted it as shown in the photo. Whatever pot you decide to use, make the hole in the panel far enough away from the calibrated dial to keep the pot from rubbing the dial after it's installed. A small diameter pot makes things a lot easier.

Tuneup Procedure

Before connecting capacitor C3 to the vfo stator, tune in a carrier and zero-beat the signal on your SSB receiver. Use your crystal calibrator if it is of the 100 kHz marker type, or use a commercial BC station that is easily *identifiable*. Pick a low vfo frequency so that your vfo tuning capacitor is almost completely meshed. This minimizes the frequency shift when you connect C3. Set the 3 kΩ pot to its center of range and connect the free end of capacitor C3 to the stator of the vfo tuning capacitor. The carrier that was zero-beat will shift frequency as you do this because you just *added* a couple pF capacitance in parallel with the vfo tuning capacitor. You will have to *remove* an equal amount from the trimmer on the vfo to bring back the zero-beat on the same carrier you had before. (Be careful not to zero-beat another carrier!)

To remove the capacitance, unmesh the vfo trimmer just enough to zero-beat the carrier like it was before you attached C3.

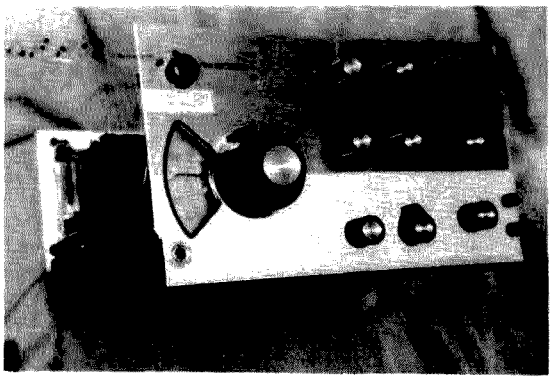
That's all there is to it; your vfo is now back in perfect alignment, and you will be able to shift the frequency up and down about 300 Hz with the pot.

Diodes to Use

I used a 1N925 TV video detector diode, but just about any type will work. Since we are only using a couple of picofarads of the diode in parallel with 30 pF or more of vfo tuning capacitance, it matters little whether the diode is a low-Q computer diode, a detector diode, or a high-Q varicap. If the diode you use doesn't give you enough shift, just reduce the value of R2 some (not below 10 kΩ, though) or increase the value of C3 (not above about 10 pF).

This $\triangle f$ control shifts both transmitter and receiver frequencies; therefore, in a roundtable discussion, if you tune off to hear a station, go back to the original pot setting before transmitting. If the other fellow has a transceiver, leave the pot where you hear him best, since this automatically makes him hear you best also.

More elaborate circuits can be designed which automatically return your vfo to the center range of the pot when you transmit, by using a contact on your transmit relay and putting a fixed bias on the diode when you transmit. The desirability of this is questionable, however. With this circuit, simplicity is foremost, and in a regular QSO, you just adjust the pot to hear the other party and leave it.



If you don't mind boring a small hole in the face of your transceiver you are sure to find a handy spot for the adjustment shaft. This one was placed in the upper left corner, right above the vfo dial.

Should you tremble at the thought of poking a hole in your "store-bought" rig, bring the pot wires out to a little handy box, so you can remove every trace of your modification later if you desire. I personally would pay more for a used rig with this control, but to each his own. You can also calibrate the pot in hertz if you have a calibrated af generator to compare its shift with.

... W4NVK ■

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Al Brogdon, K3KMO
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State College PA 16801

Hams are a funny bunch of people. They will work for days with their beam antenna orientation to make sure it is pointed to within one-half degree of the indicated direction – never considering the fact that the beamwidth of the antenna is 40 degrees.

They will overload their transmitters by factors of 50% or more, and milk that last watt out of it – when it takes a power increase of four times to make one S-unit difference.

They will stay out of a ham club and complain until the cows come home about how poorly it is run. But they never want to join and work to straighten out the club's problems.

They will spend five hours and more a day building and installing ham equipment, telling the wife all the while that they just don't have time to put a new line cord on her iron.

Some of them will crank their final amplifiers up a little and run 3 kW PEP, never thinking about the fact that they would have to run more than 5 kW to make a significant difference in signal strength above 2 kW PEP. A few of these hams have time to think this over during their license suspension period.

They will spend hours every day talking with people all over the world, but never say hello to their next door neighbor.

They will tell their wives they can't afford a new chair for the living room while they are writing out the order for a new $700 mobile installation.

They will buy surplus equipment to save money, and then spend an amount of money on it's conversion that would have bought good commercial gear that would have done the same job better.

They will set up stations with which they could communicate their ideas, but they they will give a signal report, a brief weather report, a description of their station, and run out of things to talk about.

They will spend an entire 48-hour contest period at the rig, leaving it only to catch short naps and take care of necessary bodily functions, but during the week they can't spare 10 minutes of their time to play with their kids.

They will buy complex and expensive electronic keyers so the extra dots and dashes their sloppy keying causes will be well-formed and correctly spaced.

They use Q signals on voice, and then have to use phonetics to get the letters across, since voice is better suited for communicating words than for transmitting individual letters.

They will apply for every ham award they can qualify for to document their accomplishments, when many of the certificates are for a level of accomplishment roughly equivalent to being able to cross the street without getting run over.

They will load half a ton of amateur gear and antennas into the car and take off for Field Day, but then have to suspend operation halfway through the contest because the didn't bring a spare fuse.

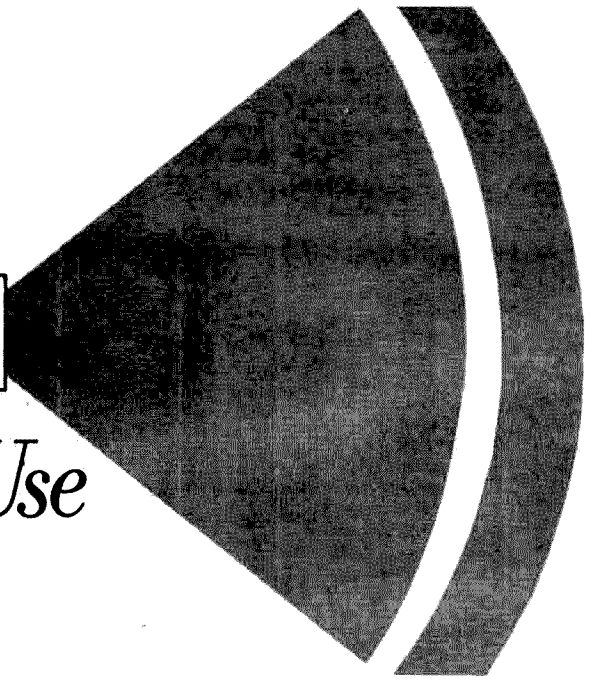
They will take great pride in being a ham radio operator, and tell all their nonham friends of the many accomplishments of ham operators, and of the advances in the state of the art brought about by hams, when they themselves haven't been on the air in three years.

But one of the funniest things of all about hams is the typically human shortsightedness of most hams. They see all the faults of their fellow hams, and they are quick to criticize, but they are not aware of their own shortcomings. Aren't you glad that you and I aren't that way?

. . . K3KMO ■

Clifford Klinert WB6BIH
520 Division St
National City CA

A 2M MINITRANSMITTER For Repeater Use



When an FM repeater finally came to San Diego last summer it was soon obvious that new possibilities and requirements were placed on 2 meter FM equipment. First of all, high transmitter power was no longer required nor desirable. In many cases output power in the milliwatt level was adequate to activate the repeater since it is virtually line-of-sight to most parts of the county. Also, high power on 146.34 MHz would cause interference with Los Angeles area remote stations that are similarly located on high mountaintops. This would add further strain to already delicate relations with the Los Angeles groups who can (and do) jam San Diego just as easily.*

Secondly, a large number of RCA CPCR2D pocket receivers had become available for portable use, but the transmitters available with them were not transistorized and the batteries were heavy and expensive. With this arrangement, and with the repeater, it became possible to have full use of the repeater while walking around on the ground in most parts of the area. This is probably the most fascinating part of repeater operation, approaching the science-fiction TV shows by being able to talk to someone a hundred miles or more away while walking around on the streets of a city with a hand-held transceiver. However, the idea of having to carry tubes and batteries while doing this was still quite revolting. Solid-state transceivers are becoming available, but are still in the $250 to $350 price range. In view of this, it was finally decided to continue work on a solid-state transmitter. This article describes the first successful results of that project.

* Ed. Note: Author is making reference to L.A.'s R.O.B.I.N. (Remotes Operated By Insociable Nets) problem.

Design

Figure 1 shows the schematic of the transmitter as it is now. The most significant part is the oscillator, which offers maximum simplicity and reliability. The crystal frequency is 18.29250 MHz, and is multiplied eight times to get the 146.34 output frequency. Amateur designs of about a year ago used oscillator frequencies in the 8 MHz or lower range. With the sloppy interstage selectivity as used in this transmitter, lower frequency crystals cause more spurious multiples because they are closer together in frequency. With a crystal frequency of 18.0 MHz, the multiples will be at least 18 MHz apart, and it is easier for the tuned circuits to select the proper multiple and reject others. A Motorola varicap is used to modulate the oscillator. With an audio input of about 22.5V

peak-to-peak (maximum bias on the diode from the power supply), the deviation is a little more than the 5 kHz at the output frequency. Two varicaps might be used in parallel if more deviation is desired – if it doesn't lower the frequency too much to compensate by lowering other capacitances.

A few notes about the crystal should be made: The crystal must be a "fundamental" cut to work in this circuit. An overtone crystal will oscillate on its fundamental frequency, and will be different

the transistors increases at lower frequencies, it is possible to have low-frequency feedback paths that have been overlooked while concentrating on the VHF circuitry.

Using the coil in each stage for the dc return to the collector not only simplifies design, but provides a low-impedance collector return for lower frequencies that would not be possible if choke-and-capacitor coupling were used.

The final transistor can be driven to as much as 2W dc input in this circuit, but was held to one watt to reduce heat

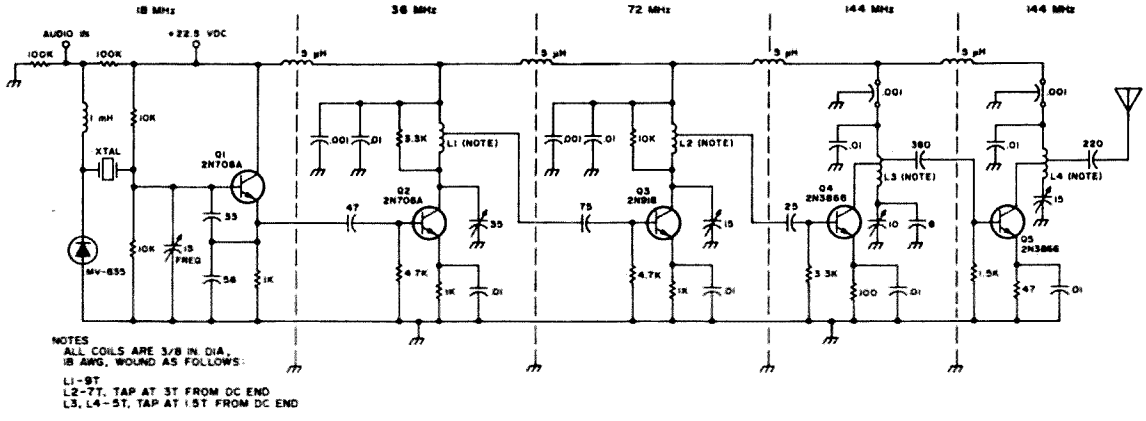


Fig. 1. Schematic.

from its marked frequency. The crystal load capacitance in this circuit is about 20 pF and this should be noted in the crystal order. A general-purpose type crystal (0.01% error) might be satisfactory, but a commercial-standard 0.001% crystal was ordered by mail, and quickly tweaked down on frequency with the 15 pF trimmer.

The three stages following the oscillator are all conventional common-emitter, LC-coupled doublers. While operating, they are driven into class C. Interstage matching is accomplished by trial-and-error tapping of the coils.

The use of ordinary resistors in the base bias circuit was found to be most successful. This avoids the resonance problems when chokes are used, and probably helps stability by lowering circuit Q. Large capacitance (0.01 μF) bypass capacitors were used to minimize the chances of low-frequency oscillation. Since the gain of

dissipation problems and battery requirements. Power can be adjusted by changing the value of the emitter resistors in the multiplier stages, and changing interstage coupling. (Ed. Note: This unit can be used to drive the DyComm 15W FM power amplifier described in 73 review, September 1970.)

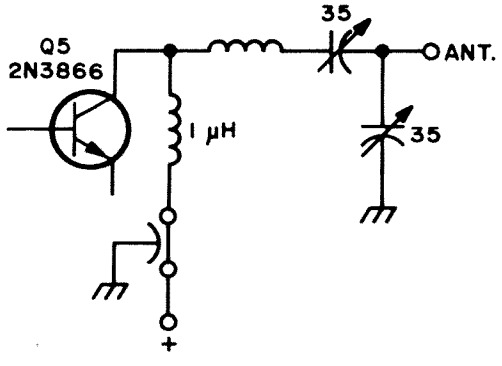


Fig. 2. Alternate Output Circuit. L can be five or six turns 3/8 inch diameter, #18 wire. Try to make it work.

A more popular output tuned circuit is included in Fig. 2, but it was not tried in the transmitter because the circuit used in Fig. 1 was considered satisfactory.

Construction and Tuning

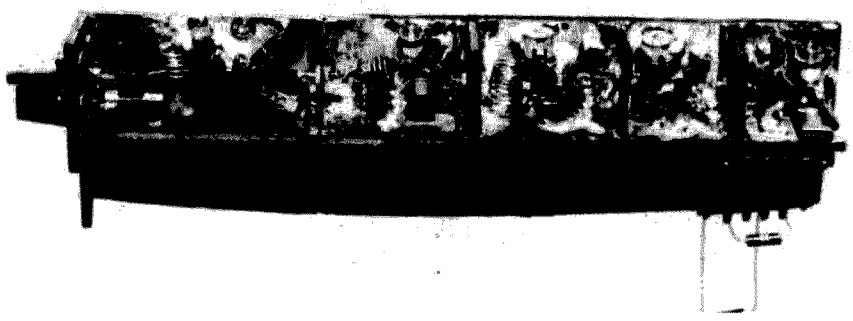
Simply having a schematic available does not mean that it will be easy to build a transmitter. Construction is very simple, but making it work will occupy the majority of the time. Since all transistors are different and any two transistors with the same number can have widely different impedance and gain parameters, the tuned and coupling circuits will require extensive adjustment. Many of the values in the schematic will probably be a little different in different transmitters.

Considerable experience as well as appropriate test equipment is required for the tuning and tweaking. A grid dip oscillator is a must, and a general-coverage receiver that can cover all the frequencies between the oscillator and final output is always handy. An swr bridge or power meter that works at VHF is necessary for tuning for output power, as well as all the other tools and test equipment that are usually available in the average shack.

his own pet methods and parts available to work with. As a final resort, industrial parts catalogs will list all the components necessary.

Speaking of parts, half-watt resistors can be used, but quarter-watt resistors will be easier to work with because of size. In the case of the driver and final emitter resistors, power considerations will necessitate the use of half-watt resistors. Small dipped mica capacitors are used for interstage coupling. Other than the feedthrough bypasses, disc ceramic capacitors were used for bypassing. Indeed they are not the best, but seemed to work in this case. Just make sure that all parts are as small as possible. JFD makes good ceramic bypass capacitors as well as small disk variable capacitors. The crystal holder is the HC-18/U type and is soldered into the circuit.

The transmitter should be built one stage at a time, starting with the oscillator. Each stage should be checked and tuned as it is built. The oscillator will be easy because there is nothing to tune but frequency adjustments and the circuit is very easy to get working. Check for output while listening to a receiver tuned to the

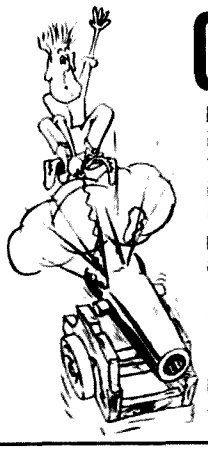


Photograph of the complete minitransmitter strip. Note how stages are shielded into "compartments."

The circuit was laid out on a double clad printed circuit board that makes a very simple arrangement. Small Teflon standoffs were glued to the board with epoxy to provide a place to solder the transistors. Details of the construction and parts to be used will mostly be left to the individual builder. Anyone who would build this transmitter probably would have

crystal frequency. Adjust the two resistors that provide the bias to the varicap to put the diode voltage at about 10V measured at the diode–crystal connection with a VTVM or oscilloscope.

An audio signal voltage can be applied at the "audio in" point in the schematic. Make sure that the audio source is isolated with a series capacitor to prevent affecting



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the diode bias. A maximum of about 20V peak-to-peak can be applied here. A preassembled imported audio amplifier can be used for modulation, or an amplifier can be built to fit individual requirements. If the amplifier is designed for driving a speaker, a transformer may be necessary to step up the output voltage. It should be possible to detect FM from the oscillator by listening to a general-coverage AM receiver and slope-detecting the signal.

Tuning the multiplier stages can be accomplished by measuring the emitter voltage of the following stage while tuning the preceding one. Voltage across the emitter resistor measures emitter current, which is a measure of rf drive. To determine that the stage is operating class C, compare the emitter and base voltage, as measured with a VOM. The emitter should show more voltage than the base. The base never really has more bias voltage than the emitter, but when the VOM probe touches the base, it partially shorts out the rf there and reduces or eliminates drive. Since the emitter is bypassed, measuring emitter voltage has no effect on the rf drive. A grid dip meter must be used for the final tuning to be sure that the state is operating on the right frequency, and to check for parasitics.

The resistors across the coils in the schematic were used as a cure for parasitic oscillations. The stage should be built without the resistor first, and then resistors can be added when instability occurs. A grid dip meter can be used to detect parasitics and oscillation, but an AM general-coverage receiver is much more sensitive.

Adjusting the output stages is just a matter of changing taps on the coils while watching for transistor overheating, checking for parasitics and oscillation, and retuning each time for resonance. Also be sure to check that the right harmonic is being tuned for on the grid dip meter used as a wavemeter.

Leave a TV set turned on; it will let you know when oscillation breaks out and give a little entertainment while you're working. Watch channel eight; the 36 MHz signal tends to come through the 72 MHz doubler, and multiply five times in the 144 MHz doubler to cause TVI on channel eight. This has been the major source of TVI after the transmitter was operating properly. A 36 MHz series-tuned trap might be used at the collector of Q3 as a last resort, but with proper tuning this should not be necessary.

The final results will take a considerable amount of time depending on the intuition or "feel" that the builder has for what is happening in the circuit.

Conclusions

This transmitter has provided good results in the final analysis, but there are problems and changes that could be worked out. The thing is quite difficult to tune and clean up, and some kind of standard chassis, housing, shield, board, or whatever should be designed to provide ease of mechanical construction and duplication, rf shielding, and mechanical strength. Double-tuned, inductively coupled interstage circuits might be used to provide better selectivity. Tapped iron slugs are available, but I haven't located a source. Supposedly, this would be much less expensive than using the ceramic variable capacitors, and much smaller.

Other variations of this same theme might include a low-power 100 mW version for short range use with an absolute minimum of size and power consumption. Be creative.

. . . WB6BIH ■

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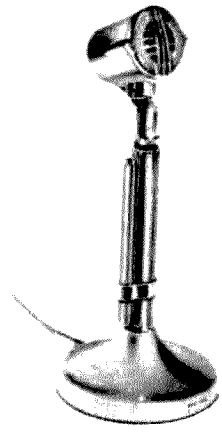
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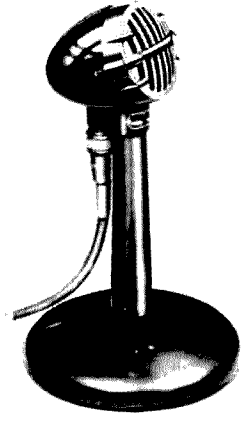


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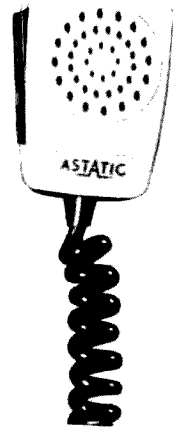
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RECEIVER OFFSET TUNING FOR THE HW 100

Want transceiver offset tuning without costing a cent? Without altering your rig? Give this a try:

The introduction of the transceiver to ham radio has brought many advantages. But the one disadvantage that will force a fellow *not* to select a transceiver is its inability to follow the drift of a CW signal without altering the output frequency. This separation of frequencies was realized by a very simple method which can be employed in many other rigs. It has two good things going for it: no modification and no money required.

Theory

The theory behind this method of offset tuning is simple when you recall some of the laws we all knew to get our ticket (and then promptly forgot as they were of no *practical* value). Inductive coupling is the first order. This is the method by which we will get the change into the rig without altering or soldering. This method will allow you to introduce a change in the frequency of the main vfo. You'll also want to be able to remove the change at will, as on transmit. Figure 1 shows that the inductive coupling links the main vfo with the added tuned circuit. It is with this outboard tuned circuit that we can change the received frequency. The capacitance of the variable capacitor should be *low*. Try and keep it in the area of the tuning capacitor of the vfo. In my rig, the HW-100, this is 63 pF, so anything near that will do. The vfo coil in my rig is 5 μH so I kept the inductor of the remote circuit as near to this as possible. None of the values are too critical as to demand adherence to strict values. By keeping close to the values of your rig you will have better tracking and zero beating of the received CW signal. And you'll know that when the remote tuner is switched out of the circuit you are still near enough to be hearing the same signal you were listening to on the offset tuning. The greater the change in the offset tuning circuit values, then the greater the coverage up and down frequency from the zero beat. I felt that in CW a great range of offset tuning was not of any use and it also would make tuning more difficult. I just about use the full rotation of my capacitor and keep within the passband of my rig, the tuning rate is slow enough that I can move it around in the 400 Hz CW filter I have added to my HW-100. It is this simple remote tunable circuit that allows the offset tuning.

Construction and Circuit

The variable capacitor I used is a BC tuning variable with only the rear section in use. If you have any old variable in the

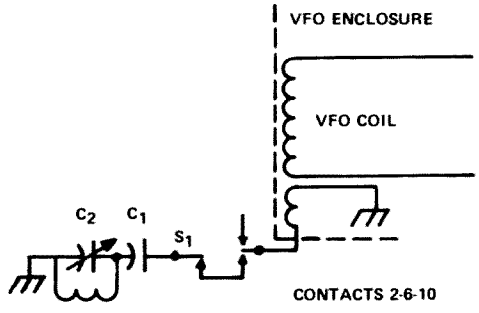


Fig. 1

junkbox, then that's the one you use. I reduced the high capacitance of this section by putting a 100 pF Mylar capacitor in series with it. (You can fool around with values until you get what goes best with your rig.)

The coil for the remote tuner was made after looking in the ARRL handbook; I found that a 1½ in. long coil by ½ in. wide (36 turns per inch) would give me close to 5 μH, which is good enough. The coil was made by winding 24-gage magnet wire, enameled, around one of those fat pencils used for advertising gags. The size of the wire is not important just so you can get about 36 turns to the inch on a half-inch diameter.

If you have spent any money up to this point you need a new junkbox. Now for the hookup.

The vfo of the HW-100 is removed according to the Heath manual instructions. Reference will be made to my HW-100, but any transceiver that allows you to get at the vfo and its coil can be used with this offset tuner. The vfo is turned bottom-side-up so the inside of the enclosure is accessible. Be careful not to damage the screened dial. One end of the pickup wire has its insulation scraped away and it is soldered to ground on the inside of the vfo, as close to the coil as you can manage. This is the only soldering and modification to the rig. In my rig, the ground for the coax feedthrough into the vfo was used as ground. With tension on the ground connection, make one full turn around the vfo coil and while still keeping tension bring the wire to the nearest spade bolt. Wrap the hookup wire around the bolt 2 or 3 times, just for anchorage. Make these turns just at the base of the spade bolt where it meets the edge of the vfo enclosure and tuck the turns down into the little space between the shaft portion of the spade bolt and the edge of the enclosure.

By tucking the turns of wire into these spaces you will keep them from being cut or grounded by compression from the edge of the vfo enclosure when it is remounted and the nuts tightened. It is most important that the turn of wire around the vfo coil stay in place without the least movement. Movement of any kind no matter how slight, even from vibration, can alter your received signal a few hertz up or down the band. A drop of some kind of glue will do the job of keeping the wire turn in place.

Remount the vfo as directed in the Heath manual. Make sure the remaining free end of wire is not caught under the edge of the vfo and is outside the vfo enclosure. The wire is now fed to S1, from S1 to C1, to rotor of C2, then to ground from C2.

If automatic switching is desired, place RL1 contacts 2-6-10 before S1. The homebrew coil is placed across the variable capacitor to ground, placing it in parallel with C2. Keep all leads as short as possible. This completes the wiring of the remote offset tuner.

Alignment

The transceiver must now be adjusted only because the loop of wire around the vfo coil has moved the vfo frequency and it will not be the same as the readout frequency of the dial. This alignment is simple because the *vfo is not adjusted*. This is the part that can be frustrating at first because you do not know where the frequency has shifted to. I found the turn of wire dropped my vfo down 30 kHz. This meant nothing had changed as far as function of my vfo except that there now was a 30 kHz shift down the band. This was corrected by "slipping" the dial on the rig until the frequency coming from my vfo and the readout frequency on my dial were the same. I used CHU, 7335 kHz, as my locating frequency. I used this instead of my signal generator only because my transceiver receives CHU (and besides, I was too lazy to set up my signal generator). Any method of obtaining a locating frequency is fine.

For alignment with the offset tuner in the circuit, tune in a CW signal on any band with the offset tuner out of the circuit. I found RTTY signals to be of longer duration and more dependable. Adjust the vfo for the highest meter reading of the locator signal. Place the

variable capacitor of the offset tuner in the fully unmeshed position. Put the offset tuner into operation by closing S1. When S1 is closed you should still receive the same locator signal if your capacitor and coil values are close to the values in your rig. One thing you may notice is a change in pitch of the locator signal due to a slight frequency shift (but don't worry about it). I am only interested in following the drift of a CW signal – not in how much frequency spectrum my offset tuner ranges over or in how many hertz the CW signal drifts. (Though this can be done if you care to take the time to calibrate for it.)

Adjust the variable capacitor so that when the remote tuner is removed from the circuit by S1, the pitch (frequency) will be close to the pitch of the signal from the rig alone. What you will be doing here is getting a zero beat for the offset tuner against the rig. Try to get this position of the offset tuner as close as you can to the rig's signal. Mark this zero beat position on the variable so you can return to it at any time. Now when you're receiving and the offset is placed at zero beat you can tune up or down frequency as a CW signal drifts. I found that my zero beat on the offset did not change from band to band. It would appear that alignment for one band takes care of all the bands. This completes the adjustment and alignment of offset tuner and the transceiver.

Placement

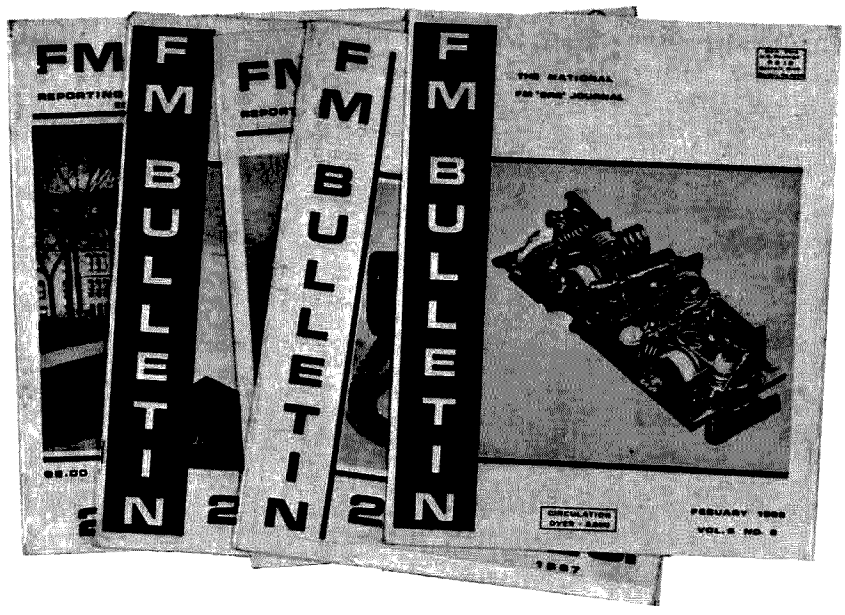
My offset tuner at present is outboard. It can be mounted in the HW-100 without making holes in the front panel. The screws in the upper right and left corners of the front panel are replaced by the variable capacitor and the on–off switch (S1). The components in this case will have to be of the miniature type to use the holes as they are now. To use what comes out of the junkbox, in my case, meant enlarging the holes. But I think this is one case where modification will add to the worth of a rig and should not be a deterring factor. The shame of it all would be spending money for miniature parts after having come this far for free.

. . . WA2EAW ■

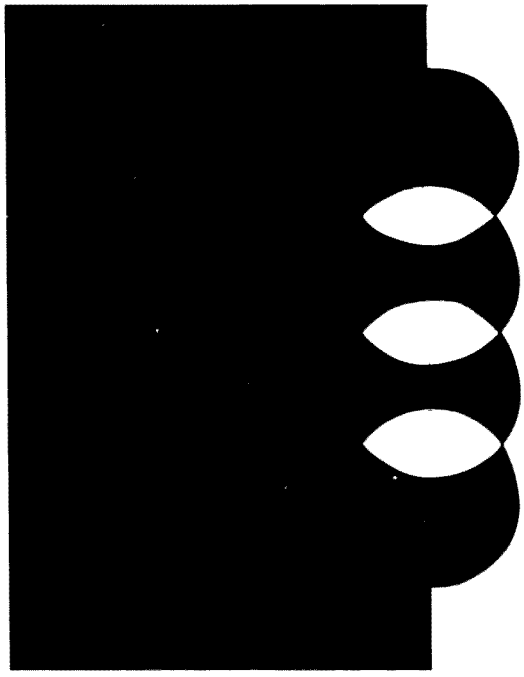
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The Little GATE DIPPER

John Aggers W5ETT
1509 Desoto
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Covering 1.7–225 MHz, it is simple, inexpensive, and easy to build.

Possibly you now own a grid dipper, but is it small, easy to handle, and cordless, making it completely portable? If not, you will want to build this gate dip meter. The cost is extremely low – only about $7. All parts are readily obtainable and construction is simple. The plug-in coil forms, using battery plugs and polystyrene tubing, are easy to make.

The Circuit

An MPF 102 FET is used in a modified Colpitts circuit. Except for the #1 coil, where a choke is used, the B+ is fed to the centertap of the coil. This is necessary to obtain a fairly constant gate current as the oscillator is tuned to its end frequencies. Drain current varies from 4 to 1 mA proceeding from 225 to 1.7 MHz. At the same time the gate current varies from 20 to well over 50 μA.

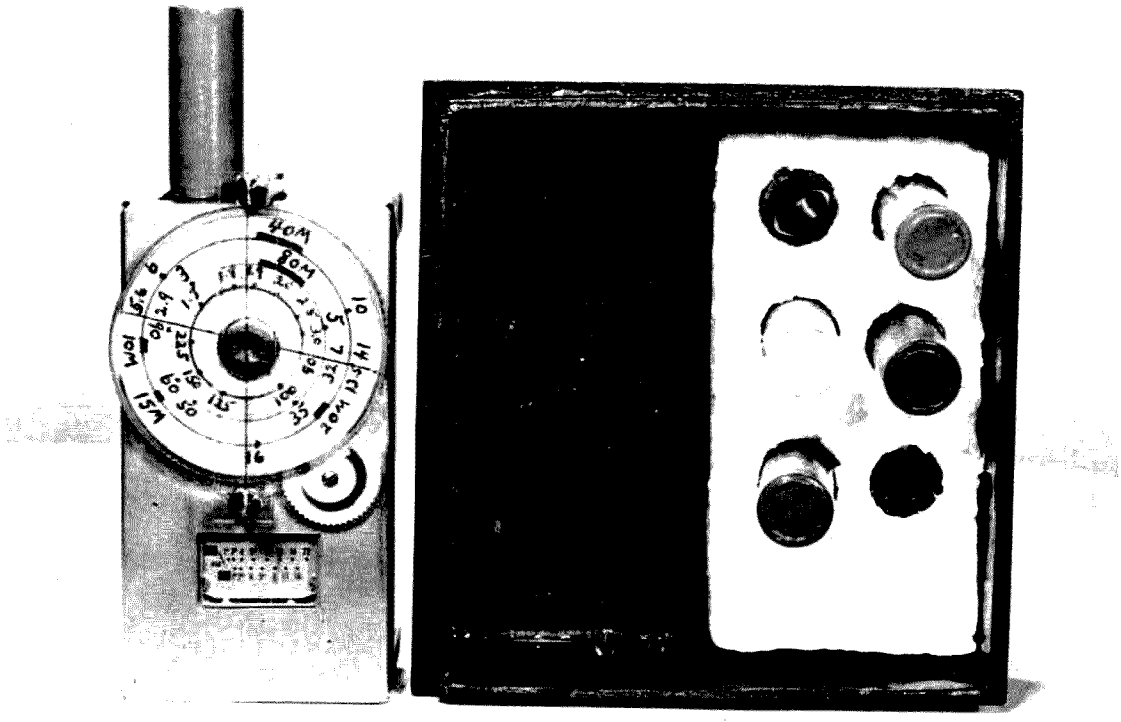
From this, it is apparent that the stronger the oscillations the smaller the drain current and the larger the gate current. In gate dip operation, as power is drawn from the oscillator the drain current will increase and the gate current will decrease or dip.

Limited wavemeter operation, obtained by switching off the B+, is accompanied by a slight shift in calibration. When the circuit picks up rf, the FET suddenly goes into oscillation using the rf as its battery. Thus, the amount of rf picked up must be large enough or there will be no oscillation and no meter indication. However, despite these deficiencies, it is still considered a useful mode of operation and for that reason has been included. It is only necessary to wire the sensitivity control so that the resistance is maximum when the switch is in the off position.

Construction

A natural finish aluminum minibox (4 x 2-1/8 x 1-5/8 in.) is used for the meter case. The variable capacitor came from an old transistor radio and measured 1 3/8 x 1/2 x 1 in. The shaft was already squared and tapped for a small screw. Since those listed in the catalogs have a plain or flat shaft, you will have to use a collar with setscrew, or drill and tap the shaft. The trimmer capacitors are not used and should be removed.

To make the coil socket you will need three pin receptacles from an octal socket, two pieces of 1/8 in. Plexiglas approximately 7/8 x 3/4 in., and one battery plug for a pattern. The pins of the battery plug form a triangle. I shall refer to the holes at the base as the outside holes. Drill holes in one piece of plastic to match the pins of the battery plug. Match the two pieces of



The little gate dipper with spare coils.

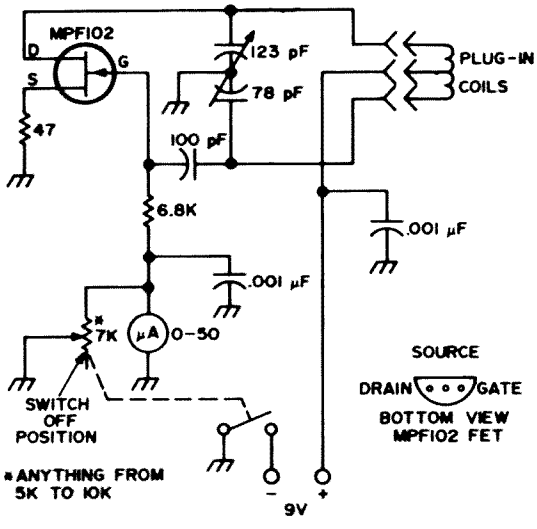


Fig. 1. Schematic diagram of the little gate dipper.

plastic, clamp in a vise, and drill the two outside holes in the second piece. Bend the lug part of each socket pin to a right angle. Slip one over each outside pin of the battery plug. Using this as a jig, solder the lug portions to the stators of the variable capacitor. Remove the plug, and the pieces of plastic should fit down over the variable capacitor. The lug part of the center socket pin is brought out between the two layers of plastic.

File a small notch in the bottom piece to accommodate the lug. Before cementing the two pieces together and to the frame, make each hole slightly larger than the diameter of the socket pins. This will allow for expansion when the plug is inserted.

The dial is made of 2-1/4 in. diameter 1/8 in. Plexiglas. To give the dial a rough edge, for good thumb traction, I heated an old gear wheel and rigged up an arrangement to rotate the dial against it. The gear should have rather coarse teeth and rotate with the dial, or you will create flat spots.

The variable capacitor can now be mounted in the case. Position it so that the top and sides of the dial will be just about even with the edges of the case.

The dial marker is mounted on square aluminum posts. The top post (2 in. long) has 1½ in. of its length filed down to a 1/8 in. thickness to reduce its bulky appearance. To make the hairline, scribe a line in a ½ in. wide piece of plastic and fill in with a ballpoint pen.

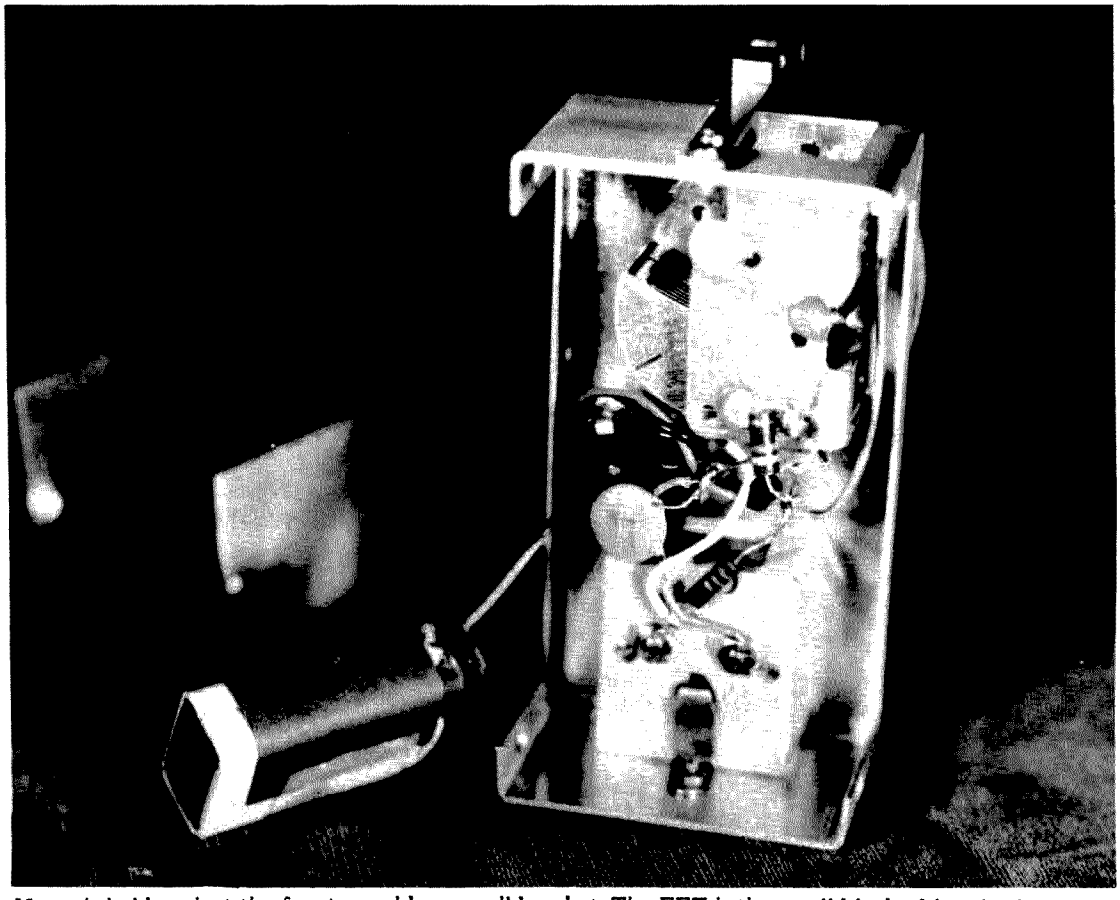
The sensitivity control I used was already prepared for the knob shown. If you don't have one like it, use a dime-size pot and a setscrew knob. Any resistance from 5 to 10 kΩ will be fine.

Keystone light meters are available from Olson Electronics in a package of five ($3.99) or Transistors Unlimited Co. (75¢ each). Some modification of the meter is necessary. Remove the light cell and series resistor. Drill two holes, spaced ½ in. apart in the back of the case to pass 4–40 machine screws for easy soldering, make sure the heads and nuts are clean and free of any nickel plating. The screws should be filed even with nuts in order to make room for the battery. Solder the leads from the meter movement to the terminals, but be quick because the plastic case tends to melt in a hurry.

Wiring is just a here-to-there proposition, requiring no terminal boards or terminal lugs. The FET is soldered in place supported by its own leads. With reasonable care you should not damage it. A battery holder was found unnecessary; however, it is a good idea to wrap a layer of tape or stiff fiber paper around the battery to prevent the metal case from shorting out the meter terminals.

Coil Construction

Figure 2 and the photo give the necessary dimensions and show the parts needed to make the coil forms. The battery plugs are listed in the catalogs to fit #482 and M3 batteries. The center pin should be filed slightly shorter to make the plug seat evenly in the socket. While you are at it, file the nickel plating from the ends of all plug prongs. This will make for easier soldering.



Meter is held against the front panel by a small bracket. The FET is the small black object in the center.

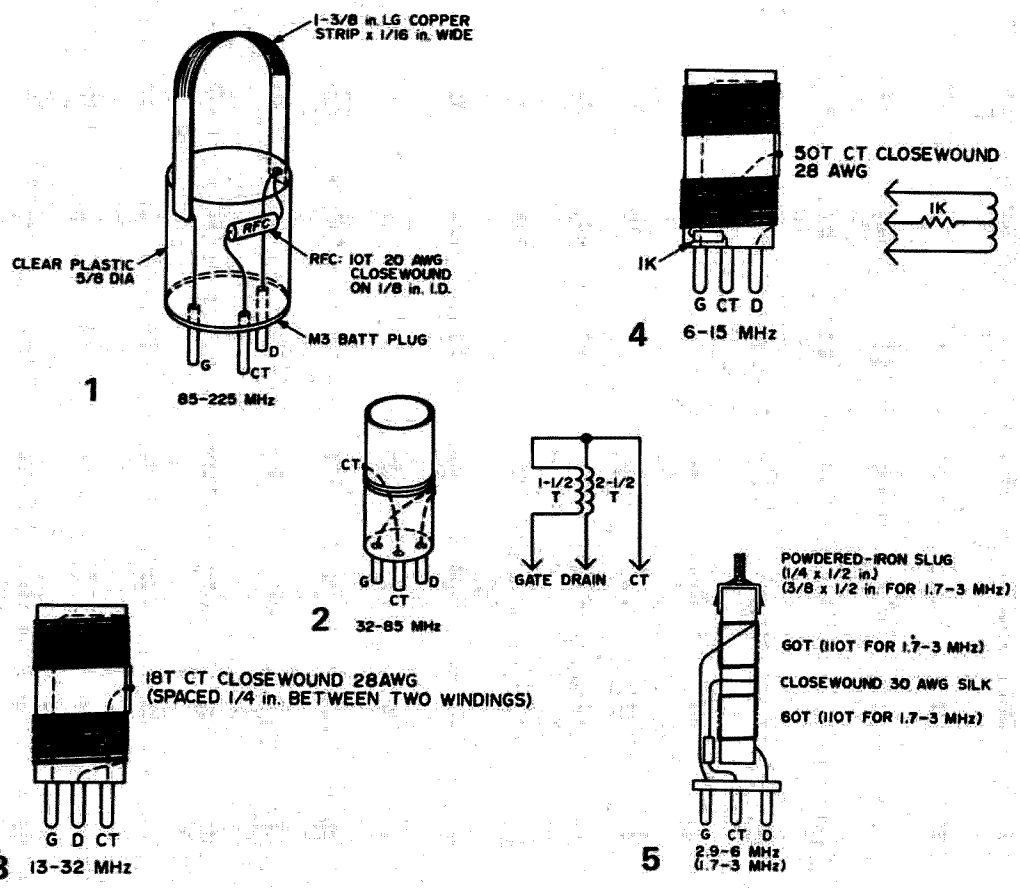


Fig. 2. Coil configurations for various frequencies of resonance.

Complete coil information is given in Fig. 2. However a little explanation may be in order. The irregular method of winding the #2 coil is necessary to reach 85 MHz and still maintain oscillation. With 4 turns close-wound the highest was too low. With the 4 turns spaced, oscillation ceased at the highest frequency. The 30 AWG silk wire was taken from a TV flyback transformer. The resistors in the centertap of the last three coils improve the meter's sensitivity slightly. They are mounted right next to the coil winding. With a slight groove filed inside the insulating sleeve, it should slip over the resistor.

The #6 coil is layer-wound as space permits and scrambled wound the rest of the necessary turns. The top winding of all coils should end near the very edge of the coil form. This will make for easier coupling to a tuned circuit. After the coils are checked out the insulating sleeves may be glued to the plug base.

Allow the glue to dry for several days before plugging the open ends of each coil with a small cardboard disk. The coils are painted with colored lacquers. Colored paper between the coil and the insulating sleeve will probably work just as well.

Calibration

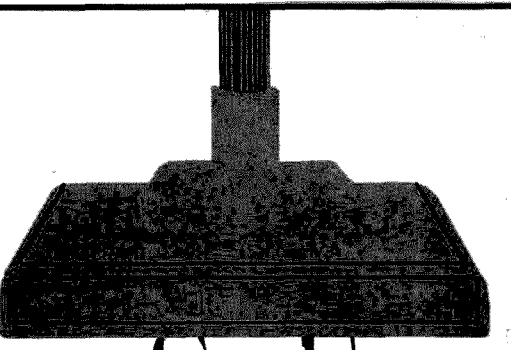
For calibration purposes, you will need another indicating oscillator or dip meter. Operate it in the diode or wavemeter mode and loosely coupled to the gate dipper. I calibrated only 5 points on each scale plus any ham bands which appeared. Remember the dipper is not a frequency meter but something to get you in the ballpark.

Conclusion

The little gate dipper was checked against a well known commercial tube equivalent and, as near as I could tell, they were just about even. The battery should last for a long time because the current drain is extremely low.

. . . W5ETT ■

Marlene F. Derfler
804 48th St. S.
Great Falls MT 59401



CLINKS IN A VACUUM

(A LOW PRESSURE ARTICLE FOR WIVES)

My husband is a builder. No, he doesn't build coffee tables or bookshelves or breakfast nooks. Instead he builds important things like linear amplifiers, grid dippers, calibrators, and all those other things you need around the average American home.

They say that Nature abhors a vacuum. Well, my husband does too. Most of the time I understand his drilling and pounding, his screams when he grabs the wrong end of a hot soldering iron, and the horrible whistle that wakes up the baby and indicates he is getting "zero beat." Our day of trial comes, however, when all too frequently it becomes necessary to vacuum the house.

We have a shaggy dog that sheds and you have to really keep after the clumps that surround him whenever he stops to scratch. This means toting out the vacuum nearly every day.

My part of the great vacuum debate comes when I start hearing the pings, clanks, and pows of "things" being sucked into my little vacuum's innards. It sounds disturbingly like bullets ricocheting among the rocks in a "B" western movie and it certainly can't be doing my vacuum any good. Investigation long ago showed these "things" to be various little pieces of plastic stripped off the ends of wires, bits of wire, melted glops of solder, small nuts and bolts, and other little indescribable things of Ham Husband origin. We have agreed that he should keep his activities confined to the spare room that is his "shack," but these things come out on his shoes, follow like a dust storm in his wake, and I think roll out by themselves in the night. Once, when I shoved a handful of "clinks" that I had gathered out of the vacuum bag under his nose, he peered at it, carefully picked out the little nuts and screws, and ran back to his shack mumbling something about precious hardware.

There is another side to the story to be sure. I usually just get the vacuum started and have suffered through the initial ten or twenty internal ricochets when he comes tearing out of that dark hole, often with headphones strung around his neck, striving to be heard over the combined noise of the vacuum motor and a sound like ball-bearing Ping Pong. After pulling the plug out of the wall (a move which someday may be fatal because he wired it himself), he finally gets across the point that my vacuum is making a horrible noise in his radio. I suppress the urge to ask him why he doesn't talk to this horrible noise just like he does to all the others and instead I ask the same question that I always ask him.

"Is there any way to cure our mutual noises without my giving up vacuuming and you giving up ham radio?" At the mention of the latter sacrilege he usually turns paler and retreats a few feet toward the comforting smell of burning solder. It is hard for him to turn any paler because the only sun he ever gets is when he works on antennas during the winter and at an occasional hamfest in the summer, but the burning solder smell is always around.

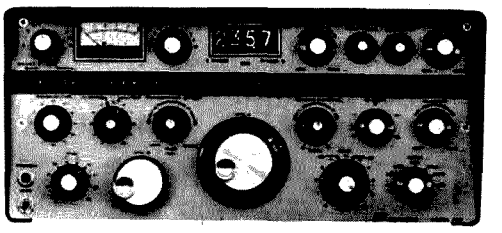
Normally then, we just stare at each other, both of us silently remembering the time he did try to do something about *his* noise. On that occasion he had grabbed up my vacuum and carried it off to his lair where he gutted it and added little round things to its insides with his ever-ready soldering iron. In a way he did temporarily solve both of our problems because when he plugged it in he blew the last fuse we had in the house. I wouldn't let him replace the fuse with a piece of solder, so he tramped out to the store muttering something about "ac working voltages."

I haven't let him touch my vacuum since, of course, but I ask him the same question each time just to bring him back to his senses. He usually is torn for a moment or two, contemplating an ocean of dog hair on the one hand and a normal life on the other. Remembering that dog hair gets into the fan on his linear amplifier, he usually compromises at this point and says, "QRX one . . ." I take the minute to pick up whatever bits and pieces and "things" I can see that he carried out with him on his last excursion. When I start vacuuming again after this mysterious ritual of "QRX" I know I'll be greeted by a sound worse than a trio of two-year-olds let loose to play with all the kitchen pots and pans.

All this that I have been telling you was true until just the other day. On that particular fateful day we had gone through our usual routine and I had asked him the usual question. This time to my amazement he said, "You know, sweetie, maybe you're right. I should spend more time with you instead of with my projects and radio. I could help you around the house. We could go out more, meet new people. I couldn't get much money for all that homebrew gear, but I could give it to somebody who could use it and then you wouldn't have any more clinks in your vacuum cleaner."

That day I was so happy! We closed the hamshack door and right then he started to help me around the house. The first thing he did to help was to shake out the rugs. The same eyes that can spot the latest transistor in a radio store window from a moving car at six hundred feet didn't see

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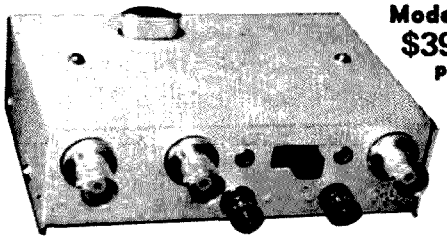
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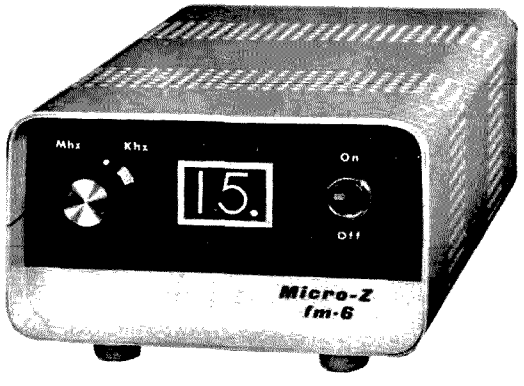
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my hand washables hanging on the line upwind, but he was helping! The second thing he did to help was to put the dark things in the washer for me. He even included the skirt to my dark wool suit which was in the pile going to the cleaners. He said he wanted to make a full load.

That night we got a babysitter and went out to dinner. He paid ten dollars for our steak dinner, and then my reformed husband suggested that we go somewhere else for an after-dinner drink. Dazzled by all the attention, I happily agreed. We had just gotten settled with our dollar-fifty after-dinner drinks when who should pass by but his old high school girlfriend and her heavy-handed, shifty-eyed husband.

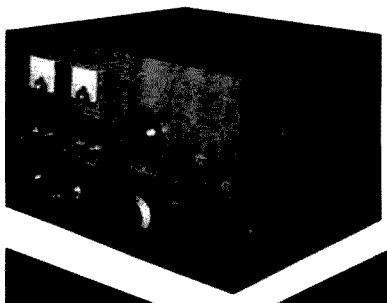
After we had paid the babysitter her ransom and my husband was taking her home, I began to think. "It would be nice to have help with the housework, but the experience might take years off my life. What would he do when he found that doing chores together really isn't much fun? Would he go to the bar with the boys and maybe run into that floozie without her heavy-handed husband? The ham friends that come over now are really quite polite, even when they are loaded down with all that stuff they carry in and out. At least now he's around if I need him. That smile on his face when he shows me his latest contraption does bring a lot of joy into the house . . ."

The next day we agreed that we should go into the hamshack together and start to clean it out. It was just by chance, of course, that I bumped against the receiver and turned it on. When that station came on calling CQ I was only curious when I asked, "Can he hear you as well as you hear him?" It was with a great deal of pleasure that I saw his eyes flash with an inner determination not to weaken, which died when flooded out by the desire to get just one more signal report.

The smell of burning solder fills the air around our house. The clinks in the vacuum cleaner are still there, but somehow they mean something different to me now than before. They mean I have a ham at home that loves me.

. . . Derfler ■

Norman Ralph W4AYI/5
124 Teresa Drive
Greenville MS 38701



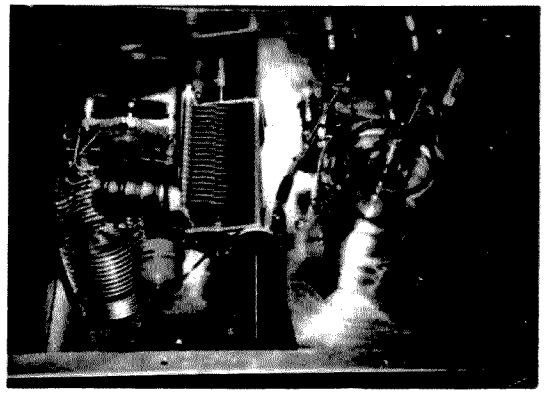
YOUR SECOND LINEAR

After building a grounded-grid linear using four 811As and modifying it, improving it, etc., I decided to build a linear that would perhaps reflect some of the knowledge and experience I had learned.

Much thought was given to what type of tube or tubes would be used. The new 3-500Z was chosen for several reasons. First, a tube requiring plate voltages in the 2–3 kV range was to be desired to keep the plate tuning capacitor to a reasonable size (250 pF). Secondly, a tube with a large plate dissipation was wanted to give a much larger margin of safety than was available with the 811As. The 3-500Z has a plate dissipation of almost twice that of four 811As. Third, the low output capacitance of the 3-500Z enables it to be used at higher frequencies much easier. Fourth, the 3-500Z efficiency range makes it very versatile. Output ranges from 750W out with 1.1 kW input at 3 kV to 500W out with 800W input at 2 kV. And finally, the intermodulation products are very low with the 3-500Z as with other zero-bias triodes designed for grounded-grid class B service. Here is a table showing typical operation of the 3-500Z.

Dc plate voltage	3.0	2.5	2.0	kV
Zero sig. pl. current	160	130	95	mA
single tone pl. current	370	400	400	mA
single tone grid cur.	115	120	130	mA
PEP input power	1110	1000	800	W
PEP useful output pwr	750	600	500	W
Resonant load imped	5000	3450	2750	Ω
Cathode input imped	115	100	100	Ω
Intermodulation prod.	−30	−33	−38 (3rd order)	dB

The schematic diagram of the amplifier (Fig. 1) is pretty much self-explanatory and there is not very much new about the design. It follows what is in the handbook and other publications. A high-capacitance tuned input circuit was used to obtain greatest linearity. Without the tuned input circuit the exciter sees a low load impedance over part of the rf cycle and a very high impedance over the remainder of the cycle. Consequently, the waveform suffers. Also with an untuned input the rf plate current return path to the cathode must travel the outside shield of the coax to the exciter plate circuit and then back the center conductor to the cathode. This can result in high intermodulation distortion. With the tuned input circuit these problems are solved as the tank circuit provides



Inside the 3-500Z linear amplifier.

a "flywheel effect" for good waveform and a short rf return to the cathode.

Many of the components used were obtained from suppliers advertising in 73. Relay K1 in the rf section is included to enable the linear to be switched in and out of the circuit with the plate voltage switch S2.

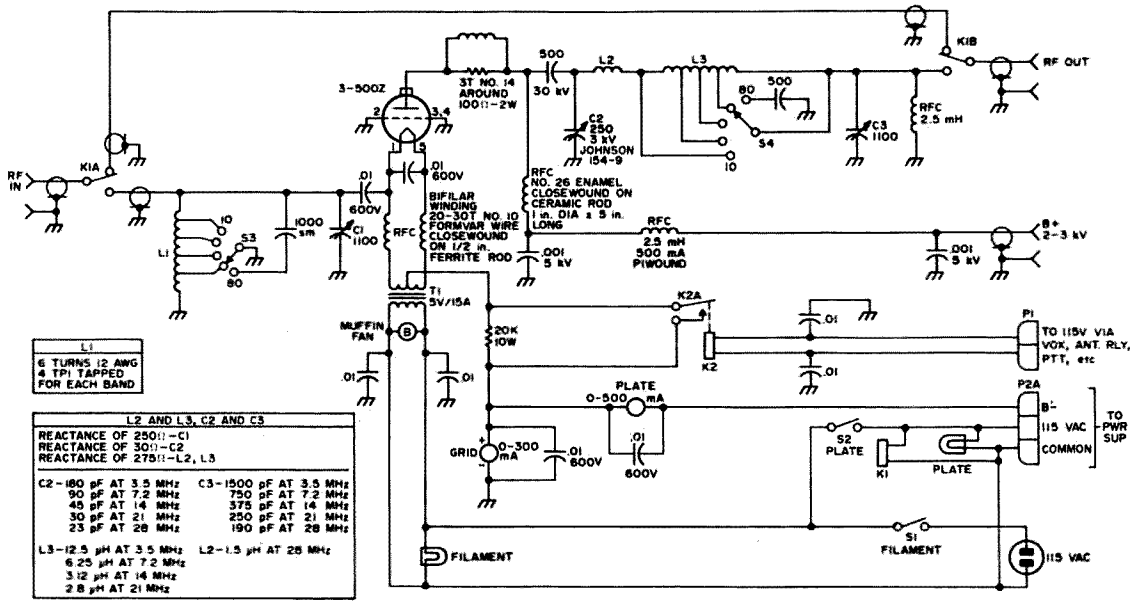


Fig. 1. Schematic of the 3-500Z linear amplifier. Coil data is shown on the table insert.

Tube Socket

The tube socket is home-made. I cut a 3 in. round hole in the chassis for the tube socket. The socket consists of a 4 in. piece of Plexiglas with a 2 in. hole cut in it (Fig. 2). Five large tinned forked terminal lugs were purchased from a local automotive store. These could be made to fit the pins of the 3-500Z by springing the part of the lug where the wire normally would be inserted. I bent the forked part at a right angle and bolted to the Plexiglas in position to take the pins of the tube.

The part of the terminal lug taking the tube pins protrudes out and down into the 2 in. hole and air can flow freely around all the pins. Short wide copper straps were run from the forked part of the terminal lugs to the chassis on the three grid pins of the tube when the Plexiglas is mounted under the 3 in. hole in the chassis. This not only effectively grounds the grid pins, but also provides a heatsink for them.

I used an SK-406 chimney, but you could use a chimney from a Coleman double mantle lantern. The lantern chimney sells for under $2, which is quite a savings over the SK-406. However, as the sides of the lantern chimney are straight, they do not deflect the air flow past the plate heat dissipating connector, so the tube should be observed closely that it doesn't overheat. A suggested remedy for this disadvantage of the lantern chimney would be to cement a ring-shaped piece of Plexiglas to one end of the chimney. The diameter would be slightly larger than the diameter of the chimney and the center hole would be 2.5 in.

The HR-6 plate heat dissipating connector must be purchased separately and lists for $2.20, but a supplier that advertises in 73 has them listed in his current catalog for less than a dollar.

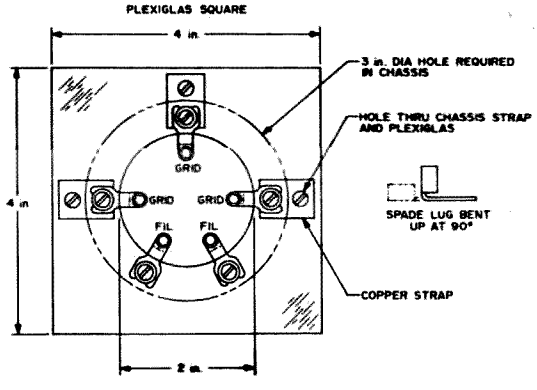


Fig. 2. Layout and plans for the do-it-yourself tube socket.

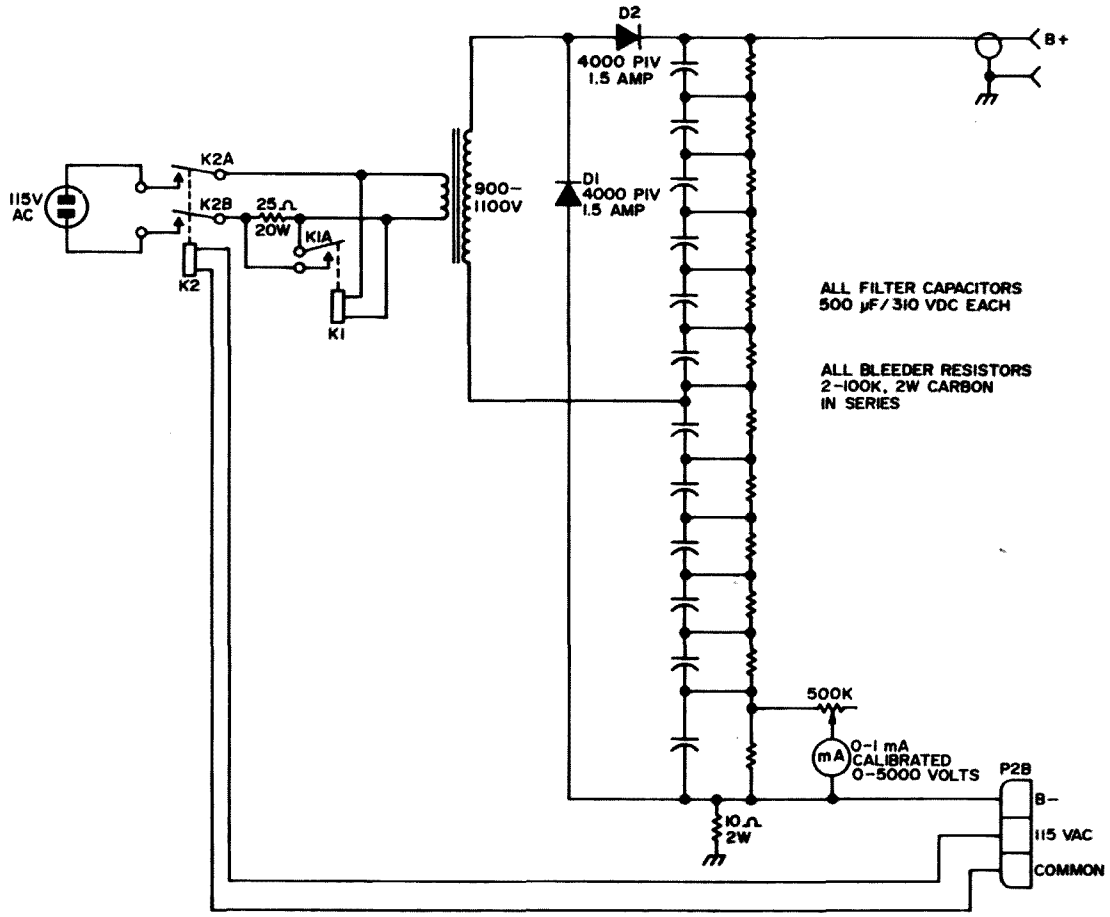


Fig. 3. High voltage power supply.

Power Supply

For the power supply (Fig. 3) I used the filament transformer from an old TV. I removed the shell from the transformer and discovered the filament windings wound on top of the primary with the secondary HV wound on the bottom next to the core. I removed the filament windings, counting the 5V windings, and then wound a new filament winding using the 10-gage wire I used on the filament choke. I taped up the HV secondary leads and they are not being used. The voltage checked out at 5.25V without the tube in the socket and 5V with the tube in the socket and lit. The shell was replaced on the transformer for maximum shielding. In use, the transformer stays cool at all times.

The pi-network is designed around a reactance of 275Ω in the coil, 250Ω in the tuning capacitor, and 30Ω in the loading capacitor. This will give you a Q of 20 if you use a plate voltage of 3 kV. If your plate voltage should only be 2 kV or you should later add a second tube your Q would still be a respectable 10. At 2.5 kV the Q is almost 14. Actual values of L and C are given in the chart on the schematic.

All the metering is done in the negative lead of the cathode circuit. This keeps high voltage off them and allows the grids to be grounded direct. The panel meters are small imported ones that sell for less than $5 each. The voltmeter in the power supply could be mounted in the rf section if desired.

The power supply is of standard design with a full-wave voltage doubler system that gives an approximate no load voltage of 2.8 times the secondary. Voltage regulation will depend on transformer capabilities and house line voltage regulation as well as the output capacitance of the filter. The filter capacitors used here were pur-

chased from an ad in 73 for $1 each and provide over 40 μF of filtering.

A relay and 25Ω 20W resistor was put in the primary circuit of the transformer as shown in the schematic to protect the rectifiers from the high surge of current that occurs when the large filter capacitors are charging. The other relay was installed in the power supply to keep the control wiring to the rf section in a small cable of 20-gage wire.

The power supply is a separate unit. It is in a well ventilated, completely enclosed box that is kept under the operating bench.

Finishing Touches

The rf section is enclosed in a home-made cabinet. I had a local sheet-metal shop cut and bend the aluminum to my specifications. I painted the panel a light gray and the bottom and top cover are painted black. The tube and input circuit are mounted on one side of the cabinet, and the pi-network and filament transformer are in the other half of the cabinet. An access panel was cut in the bottom plate under the chassis and a Roton muffin fan mounted on the cover plate. Rubber feet were mounted on the bottom to let air under the cabinet.

There you have it – a linear that no longer looks like a "Rube Goldberg" special and is pleasing enough to the eye to be placed alongside your exciter. There is, by the way, enough room in the rf section for a second 3-500Z if you have power supply enough to handle it.

. . . W4AYI/5 ■

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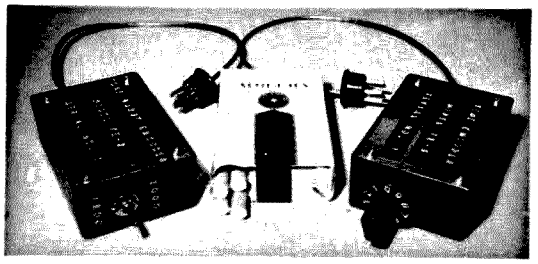
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STUDY GUIDE GENERAL CLASS LICENSE

Part V Something for Nothing

For nearly 50 years, the vacuum tube reigned supreme and virtually unchallenged as *the* amplifier for electronics. From the passing of the spark gap and decoherer in the years following the first world war until the advent of the transistor in 1948, the vacuum tube had no serious competition.

The period of the vacuum tube, not entirely by coincidence, was also the time during which electronic engineering as it now exists made the major part of its growth, and the characteristics of the vacuum tube left their indelible imprint upon the entire field.

And despite the phenomenal growth of semiconductor electronics, some areas yet remain the province of the vacuum tube. UHF amplifiers, cathode-ray tubes such as TV picture tubes, and high-voltage devices are three major regions in which the vacuum tube remains the least expensive device to do the job.

Both because the vacuum tube is still in wide use, and because many other areas of electronics and radio in particular are built upon a foundation derived from vacuum-tube experience, the General class amateur examination contains a number of questions dedicated to determining the applicant's knowledge of vacuum tubes and their operation.

The specific questions in the FCC study list are:

5. Describe the operation and usage of a cathode follower.

8. How is the plate circuit efficiency of a vacuum tube determined?

14. What is meant by the maximum plate dissipation of a vacuum tube?

51. Compare the operating features of the grounded-grid and grounded-cathode amplifiers.

Not one of these four questions makes any sense at all, unless you are already familiar with the principles upon which a vacuum tube operates. Before we can get into the details required for the FCC questions, therefore, we must delve into just how tubes do their job. Then we can examine the various ways they are used and the factors which limit their use, to determine answers to the exam questions.

Our first question, then, will be "How does a vacuum tube work?" When that is out of the way, we can move on to learn "What factors limit a vacuum tube's usefulness?", and finally find out "How are vacuum tubes used?" By the time we get even a brief view of the realms opened up by our final question, we should have adequate knowledge of tubes and their operation to handle any questions such as those on the study list.

With such a broad set of questions, and limited space in which to explore them, we cannot go into excessive detail about any part of vacuum-tube operation. Here, we're only providing enough to satisfy the General class exam questions.

How Does a Vacuum Tube Work?

Before we can determine how a vacuum tube works, we must first determine just what a vacuum tube amounts to. Even though we know that by "vacuum tube" we mean only those gadgets used in radio transmitters and receivers, that still leaves an almost unbelievable amount of territory – diodes, triodes, tetrodes, pentodes,

hexodes, heptodes, multifunction tubes, klystrons, magnetrons. . .The list doesn't go on forever, but it might as well.

All of those special types of tubes share the fact that they consist of electrodes sealed into a tube full of vacuum. Since "vacuum" is defined as the absence of anything else, that's where our phrase about "something from nothing" derives. Unfortunately as we have just illustrated, that's not precise enough to sort out the kind of "vacuum tubes" the exam is concerned with.

Rather than try to define all the differences, let's start with the one common element and see what develops.

We already know that an electrical circuit, to be a circuit, must be complete. That is, it must have both an input and an output. Even the simplest vacuum tube, then, must have at least two different electrodes sealed into its vacuum, one for input and one for output.

The first recorded vacuum tube was just about that simple. It was built by Thomas A. Edison in 1883, and its operation as a vacuum tube was purely accidental. Edison was trying to improve his newly invented incandescent lamp, and one of his experiments was to put a metal plate into the bulb near the filament (Fig. 1). He discovered that when the filament lit, a small electric current flowed between plate and filament. The discovery was duly noted, published, and became known to the world as "the Edison effect." Since it did nothing either way for the operation of the light bulb, Edison apparently ignored it and went on to other inventions – thereby missing the chance to become known as the inventor of electronics atop all his other laurels!

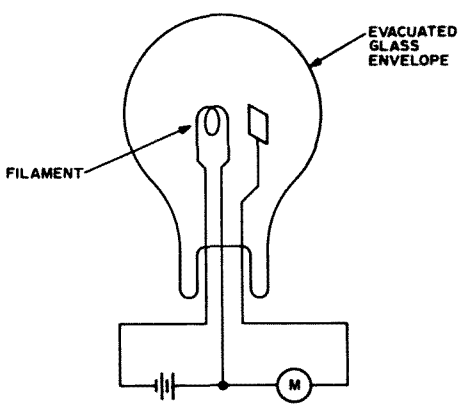


Fig. 1. Vacuum tube owes its existence to Edison effect, discovered by light bulb's inventor. Circuit which revealed Edison effect is shown here. Metal plate was sealed into bulb, near filament but electrically insulated from it. When filament lit, current flowed between plate and filament. More current flowed when plate was connected to positive pole of filament battery, than when connected to negative. Edison didn't know why this happened; others followed it up.

Serious scientists did, however, sit up and take notice of the Edison effect. As a direct result of it, Sir. J. J. Thomson spent several years in study and experiments, and in 1900 or so announced to the world his "electron theory." That's the familiar structure of electrons, protons, and neutrons which we accept now as the "true" picture of the way things are made, and the reasons for electric current.

The electron theory explained the current of the Edison effect as an "evaporation" of electrons from the surface of the filament, caused by the heat energy present in the filament. As these electrons boiled off, some struck the metal plate – and any time we have electrons in motion, we have to have a current. That's the current Edison observed.

Edison also noticed that when he connected the metal plate to the positive side of a battery, the current flow went up, and if the connection was to the negative side, the current went down. This showed that the moving particles had to be negative in polarity, since they were attracted to a positive pole and repelled by a negative one.

A few years later, in 1905, an Englishman named Fleming obtained a patent on a device making use of the Edison effect, which he called a "valve." It was intended to detect radio signals by making use of the one-way property inherent in the current flow from a hot filament to a metal plate (anode). It worked in just the same way as today's diode detector circuits, and it established the vacuum tube as a part of the growing art of radio communications.

Let's look a little more closely at just what goes on in the simple diode, since it was the first vacuum tube to be discovered,

the first to be used, and is still the basis of all conventional vacuum-tube action.

We have, as we have mentioned, two elements inside the vacuum for a diode. One is known as the cathode, and the other is called the anode, or plate.

The cathode is normally heated to a rather warm temperature (between 1000 and 3000°F.) The heating may be done by a separate "heater" which is electrically insulated from the cathode itself, or it may be done by forcing a current through a high-resistance cathode material. Normally, an indirectly heated cathode makes use of a "heater," and the word "filament" is reserved to mean a combination heater and cathode. So far as the basic principle of operation is concerned it doesn't make much difference where the heat comes from so long as it's present, but in practice if ac is used to provide heating power it's better to keep the ac out of the signal circuits, and so the heater–cathode combination is most frequently encountered in ordinary tubes.

At the cathode temperature, some of the electrons of the cathode material literally boil off into the empty space surrounding the cathode. This forms a cloud of electrons known as the "space charge" around the cathode itself.

The plate or anode is separated from the cathode by distance, and it's far enough away that the space charge never quite reaches it.

Under these conditions, with no voltage applied between plate and cathode, the space charge is self-limiting. It always contains all the electrons emitted (boiled off) from the cathode, and so always has a negative charge which just balances the positive charge produced on the cathode by loss of the electrons.

If the temperature of the cathode is raised so that more electrons are emitted, the space charge will increase, but the current flow to the plate will remain essentially zero. Similarly, if the cathode temperature is lowered, the plate current will remain unchanged at zero.

If we return the cathode to "normal" temperature and put a small positive voltage on the plate, the picture changes. The positive voltage on the plate attracts some of the electrons from the space charge, and a current flows between plate and cathode.

Not all the emitted electrons reach the plate, though. When we put voltage on the plate, this created a "voltage gradient" from cathode to plate something like a hill in the path of the emitted electrons (Fig. 2), and only those electrons which left the

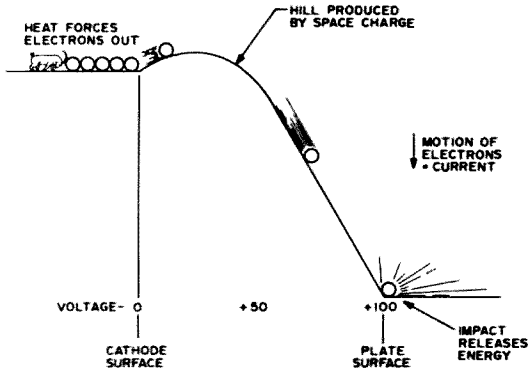


Fig. 2. Action of electrons inside simple diode tube is shown here. Difference in voltage between cathode and plate surfaces forms a "voltage gradient" shown here as a downhill slope. Space charge puts a hump in this hill, near the cathode. Angry ram represents action of heat, boiling electrons off the cathode surface. Those electrons with enough energy to make it over the hump fall down the hill, and hit the plate with a crash, releasing more heat.

cathode with enough energy to "make it up the hill" go to the plate. Some are repelled by others in the space charge, and a few even return to the cathode as a result.

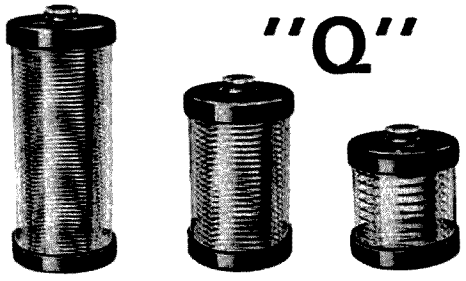
Making the cathode hotter doesn't change things much – but if we cool it down somewhat, the number of electrons in the space charge is reduced and we find that the "hill" is not so steep. As the temperature cools, we find one point at which all the emitted electrons go over to the plate.

We can achieve the same effect without changing cathode temperature if we simply increase plate voltage. When plate voltage is high enough, it will pull all the electrons over the hill.

In a diode, we have only these two factors available with which to vary the

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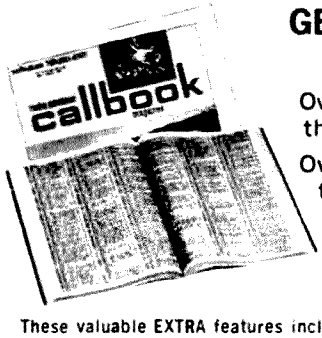
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plate current. If either stays constant, the other exercises control (so far as it is able). With constant plate voltage, cathode temperature will determine the current up until the increased space charge with increased temperature makes the hill "too high" for the plate voltage to pull electrons over. With constant cathode temperature, plate voltage will be the ruling factor until it is great enough to pull all the electrons over the hill, at which time temperature again takes over.

This "hill" effect determines the maximum power dissipation rating for the tube, in a slightly indirect manner. The "hill" is *between* cathode and plate, so that electrons leaving the cathode must "climb up" the hill to get past it, and those which reach the plate are "falling down" the other side. (The analogy to a hill is not quite real, but if the voltages are plotted on a graph as in Fig. 2 it's close enough for all practical purposes.)

The more electrons that hit the plate, or the harder they fall, the more shaken will be the molecules of the plate material. This shaking up of molecules is what we generally call heat, and a large amount of it goes on in a typical vacuum tube. Plates often run at a dull red glow, and some tubes are designed to operate with their plates white hot – with the heat *all* coming from the impact of the electrons falling down the "voltage hill" between cathode and plate.

Any material eventually gets hot enough to melt, and the plates of vacuum tubes are no exceptions to this rule. For this reason, any tube is rated for a "maximum plate dissipation" which is the power in watts the plate can safely convert into heat. Power is the rating factor because it includes current (the number of electrons hitting the plate) – and voltage (the hardness with which they fall). It's also easy to calculate and to measure, in operation.

While we've explained "power dissipation" ratings in terms of the simple diode, it's the same situation for any kind of tube. Not only the plate is involved, either. Any electrode which is more positive than the cathode (on the "downhill" side of the voltage hump) must dissipate the impact energy of the electrons that get to it, and

such electrodes are individually rated for maximum power dissipation.

The diode's main usefulness in radio today is as a polarity-sensitive switch (Fig. 3). If the plate is positive to the cathode, it conducts a current, while if the plate is negative, the electrons are repelled and

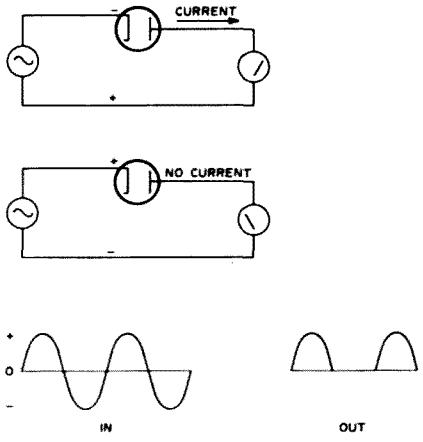


Fig. 3. Primary use of diode in electronics today is as a switch. When plate is positive (top) current can flow. When plate is negative (center) no current flows. This action can be used to change ac input into pulsating dc output (bottom), or to detect the envelope of an amplitude-modulated radio signal, as well as for many more exotic uses not strictly a part of radio.

current flow stops. This makes it useful as a power rectifier to change ac to pulsating dc, and also as a nonlinear device for modulation, mixing, and detection of signals (which we'll explore later).

The first great advance over the diode came about when Lee DeForest surrounded the cathode with a coil of wire which he called the "grid" (Fig. 4). By applying a negative voltage between the grid and the cathode, it became possible to add a new dimension of control.

For proper operation of a triode, as the three-element tube is known, cathode temperature and plate voltage are kept in the range where plate voltage controls cathode current. The plate is kept positive to permit large currents, but the grid is kept negative so that it repels electrons from its neighborhood and so holds down the plate current.

The effective "size" of the grid, as it shows up in its interference with plate


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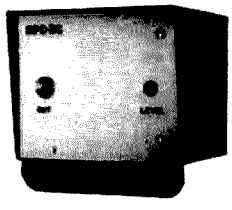
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current, depends upon the voltage applied to it. The more negative the voltage, the more effectively the grid blocks current flow. It's possible with most tubes to bring plate current down to zero by putting an extremely negative voltage (known as "cutoff voltage") on the grid. If, on the other hand, the grid is allowed to reach a positive voltage, it acts just like another plate, and loses its control of current flow.

For normal amplifier operation, the "bias" voltage applied to the grid is somewhere between the limits of cutoff and positive voltage, and is chosen so that the variation in plate current which results when small changes occur in the grid voltage is a reasonably true replica of the variations in the grid voltage. Picking the right combination of plate voltage, plate current, and grid bias to achieve this happy effect is one of the fine points of engineering design work which we won't go into deeply right here.

For our purposes, we can think of the tube as something a little different. As we mentioned in our previous installment, either a tube or a transistor can be considered to be just a resistor in the circuit from cathode to plate, with the value of the resistor being controlled by the grid voltage.

This is a somewhat unconventional approach to the matter – and one you won't find in any engineering testbooks – but it works. Keep in mind that the more

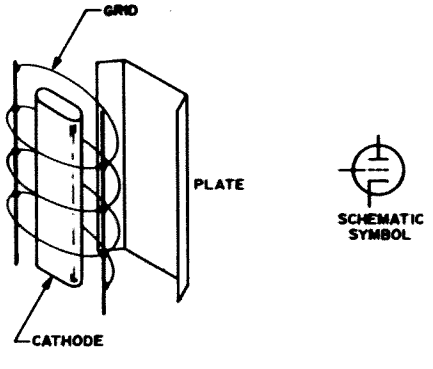


Fig. 4. Introduction of grid between cathode and plate made it possible to control cathode current by means of a separate isolated electrode, and gave birth to electronic amplification as we know it today. Appearance of simple triode is shown at left; schematic symbol is at right.

negative the grid-to-cathode voltage, the more ohms in the "resistor" presented between plate and cathode connections, and the less negative the grid, the fewer ohms in the "resistor." As grid voltage goes positive, then, the resistance value goes down and more current flows. If the tube is in series with a fixed resistor, this will reduce the voltage at the plate, and we have a change in plate voltage which is brought about by the change in grid voltage which is 180 degrees out of phase.

When used in this manner as an amplifier, the triode vacuum tube operates almost exactly like the transistor except that its resistance is controlled by the *voltage* on its grid rather than by the *current* injected into the base, and it uses somewhat higher voltages than do most transistors.

However, both the triode and the transistor share a common problem. The grid and the plate are both conductors, and they are separated by an insulating medium. This makes them form a capacitor – which permits some of the plate voltage to feed back to the grid. This plate-to-grid capacitance makes the triode tricky to handle as a radio-frequency amplifier (and the transistor too, for that matter, but we're talking about tubes at the moment).

To solve the problem, another grid structure was introduced between the original grid (now called the "control" grid) and the plate. The new grid, being added to screen the control grid from the plate, was called the "screen" grid. It was, like the plate, connected to a positive voltage so that it had little or no effect upon the electron stream passing through, but was bypassed through a capacitor to ground to prevent any signal from coupling back through grid–plate capacitance.

The screen grid worked nicely, and the resulting structure is known as a "tetrode" because it has four elements. However, it introduced a new problem. Sometimes the plate voltage is driven to a value *lower* than the screen voltage. Electrons still hit the plate hard – hard enough to knock a few "secondary" electrons free. These secondary electrons then went to the screen

rather than returning to the plate. The result was an effective "negative resistance" between plate and screen under certain conditions, which could cause oscillation.

The direct cause of this effect was the fact that the screen was the most positive thing around when secondary electrons were released. A direct cure was installation of still another grid, the third, between screen and plate. This "suppressor" grid is connected to the cathode, so that it will be more negative than either screen or plate. When secondary electrons leave the plate now, the negative charge on the suppressor grid drives them right back where they came from.

With five elements – a cathode, three grids, and a plate – the resulting tube is known as a pentode. Most present-day rf amplifier tubes are pentodes. Some power tubes are "beam power" tubes; they make use of special beam-forming plates attached to the cathode, which focus the electron beam in such a way as to create a "virtual suppressor" by space-charge effect between screen and plate.

Each of the additional electrodes introduces a small amount of noise into the signal. Normally this is of no consequence, but in critical applications such as the first stage of a VHF receiver, triodes are still preferred despite their problems simply because of their low noise.

The many other kinds of tubes you may meet are, for the most part, combinations of the kinds we've examined here. They all start out with the elements of a diode, and all conventional tubes then add grids as necessary to do their job. Often two or more separate tubes are combined in the same envelope for convenience (the 6U8A (Fig. 5) is an example of a triode and a pentode sharing the same chunk of glass), but the essential structure remains unchanged.

What Factors Limit a Vacuum Tube's Usefulness?

The vacuum tube is a most useful gadget, but each individual one is limited in its use by a number of factors. One of these, power dissipation, we've already met. Some of the others include such things as the circuit efficiency, operating frequency limits, and power requirements.

The major limits on any specific tube are those set by its power requirements, power dissipation, and operating frequency limits. The power requirements include both the power necessary to heat the cathode and that required to operate the tube's plate circuit (and screen, if any). Power dissipation involves not only the ratings, but the method by which the tube is cooled. Frequency limits are usually one-sided. Almost all tubes will operate at frequencies down to and including zero (or dc), but every tube has an upper frequency limit beyond which it will no longer act as a tube should. Let's examine these in reverse order, looking at the frequency limits first.

The absolute frequency limit in any tube is set by the physical distance between its electrodes. The electrons in the tube do *not* travel at the speed of light; they take a definite amount of time to make the trip from cathode to plate. If the signal frequency is so high that the distance from cathode to plate is an appreciable part of a wavelength, then everything goes sour. For instance, a positive-going signal at the grid should increase plate current – but if it's a half-wave from grid to plate, the plate current will be decreasing at that instant rather than increasing, and cannot increase until a half-cycle later when the grid signal is going negative.

Almost no tubes actually make it up to this limit, though. Other factors impose even lower frequency limits on them. One is the combined effect of the cathode

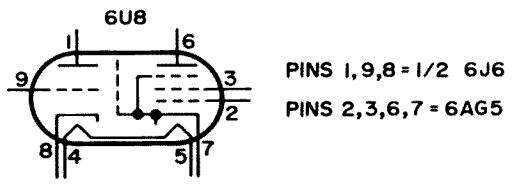


Fig. 5. Combination tube such as type 6U8 is actually two different tubes enclosed in same glass envelope and sharing same heater for convenience. Triode half of 6U8 is same as half a 6J6, while pentode portion is same as a 6AG5. Portions can be used independently.

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structure's own inductance and the capacitance from cathode to each other element in the tube. Taken all together, these effects add up to a low-pass filter circuit which prevents any signals above the filter's cutoff frequency from flowing through the cathode – and so makes the tube unusable at these higher frequencies.

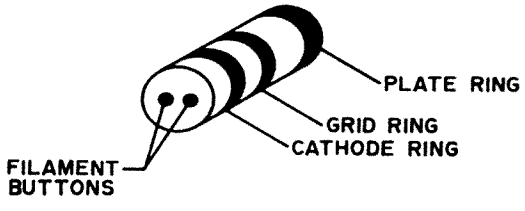


Fig. 6. In quest for UHF operation, tube designers have come up with strange designs. One is this "planar" triode which is made of ceramic, with electrode connections coming out as rings around tube body to eliminate lead inductance as much as possible. Tube operates well into UHF region, but still has an upper frequency limit.

Tube designers combat these limits by making tubes intended for VHF operation physically small, and providing multiple connections for all elements. An extreme example is the family of tiny "planar" triode tubes made for space use, which have no connector pins as such. Instead, each element is brought through the envelope as a ring (Fig. 6). Distance between elements is reduced to thousandths of an inch. The tubes operate far into the UHF region – but they still do have frequency limitations.

Power dissipation comes about because the electrons which compose the cathode current have energy, and release it in the form of heat when they get where they're going, as we already saw. The limiting factor here is almost always purely physical; when things get just so hot, they melt. It's not uncommon to see overloaded power tubes with large dents in their glass envelopes, where heat has softened the glass to such an extent that anything can change its shape!

The type of cooling provided has a lot to do with the limiting effects of power dissipation. If a stream of cool air blows past a tube, it can handle much more heat than if it is sealed into an airtight box of polished aluminum. Very-high-power tubes are often liquid cooled, with water actually flowing through the interior of the plate structure just like an automobile engine's cooling jacket. Published ratings usually assume good ventilation is provided.

Power requirements limit the usefulness of tubes in a number of ways, most of them indirect. In comparison with a transistor, for instance, a tube requires much more power – so much so that the vacuum-tube portable radio is almost extinct now. More power is necessary for heating the filament of just one radio tube than is used by all the transistors of an average pocket receiver.

Similarly, in the case of mobile radio equipment, those tubes which require extremely high plate voltage supplies, or high current, are usually ruled out because operating power is limited.

In some instances, even when high voltage and high current are available, the comparative danger of high-voltage oper-

ation as compared with low-voltage circuits (transistors, etc.) tends to swing the choice away from the tube.

Circuit efficiency also limits the usefulness of any circuit, not just those using tubes. In general, the efficiency of any circuit is the ratio between power put *into* the circuit and power taken *out*. For vacuum-tube amplifiers, it's sliced a little thinner in the standard definition of plate circuit efficiency.

Plate circuit efficiency, according to this definition, is the ratio of *signal* power output to *supply* power input (Fig. 7). It

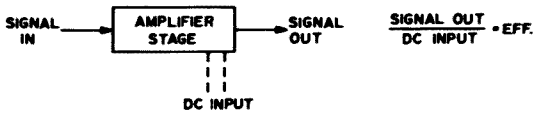


Fig. 7. Efficiency of an amplifier or a circuit is figured as shown here, by dividing signal output power by dc power put into the stage. Input signal power is ignored in the calculation.

has nothing to do with signal power input. Thus, an rf amplifier which operated on 1 kV plate supply and drew 500 mA current would take 500W from the supply. If it delivers 300W of rf output, its plate circuit efficiency is 60%.

While circuit efficiency up to 95% or better is possible on paper, almost no working circuit has ever been built which gets better than 75 to 80% efficiency. The trouble with the higher efficiencies is that they measure all rf power output, not just that at the signal frequency. In order to get figures above 75%, it's necessary to choose operating conditions which greatly increase the percentage of harmonics in the output – and all the "extra" output power consists of just those harmonics!

Most audio power amplifiers are far less efficient than this. Typical figures are around 20 to 25% for "moderate" distortion. We'll get into this a bit more a little later when we look at some of the ways in which tubes are used.

The definition of plate circuit efficiency contains a built-in loophole, and in the early days of SSB operation many operators took advantage of the same loophole (which was also in the FCC rules at that time). The loophole is this: signal power input is not taken into account.

Some types of amplifier circuits use only a small fraction of the input signal as input, and feed the rest right on through into the output circuit. Such an amplifier can, for instance, accept 100W of signal input power, amplify 10W of it by a factor of 30 to get 300W, and feed through the remaining 90W of input to the output. The output power will be 390W, yet the amplifier produced only 300 of them. If input power were to be reduced to 10W, output would drop only to 300. And in either case the dc supply power taken by the circuit would be the same. This means that the same circuit might produce 300W at an efficiency of 60%, or 390W at an efficiency of 78%, with no change in the circuit or its adjustments!

For the definition of efficiency, this loophole is closed by requiring that only the power output *produced by that circuit* be used in calculating efficiency.

The loophole in the rules had to do with the maximum power limit. It was originally stated as "1 kW to the transmitter stage which delivers power to the antenna," and the fellows who found the loophole went through it by using a 1 kW final of a type which could feed through almost unlimited power, and driving it with a 10 kW "driver." Most of the 10 kW, of course, would go right on up to the antenna, with apparent efficiency in the final of several *hundreds* of percent.

The loophole no longer exists. Part 97.67 of the current edition of the Rules and Regulations states that power input shall now be measured to "the tube or tubes" delivering power to the antenna, and the Commission has served notice that in the case of feedthrough amplifiers, this is interpreted to include all driver stages as well.

How Are Vacuum Tubes Used?

While at first glance it would appear that vacuum tubes are used for many purposes, we can compress all the uses for the ordinary garden variety of tube (that is,

all except such special-purpose items as TV picture tubes, oscilloscope CRTs, tuning indicators, and the like) into one, with our "voltage-variable resistance" concept introduced in the previous section.

The diode, for instance, when it is being used as a rectifier, changes from being a very high resistance (when cut off) to a relatively low resistance (when turned on). The amplifier simply controls the flow of current between two terminals in response to the voltage between one of the two and a third. The oscillator is simply an amplifier connected in a special circuit. Even the digital logic circuits used in early electronic computers for timing and storage can be viewed as resistances controlled by voltages.

The exact characteristics of any individual type of tube such as, for instance, the 6C4 triode, depend upon the materials from which it is made, and primarily upon the shape and spacing of its electrodes.

These shape and space factors are generally called the "internal geometry" of the tube type, and they fix the amount of effect the grid voltage will have upon plate current, the maximum plate dissipation, the maximum cathode current, etc.

If you know the geometry of the tube – or what amounts to the same thing, know what its effects are – you can apply the tube in almost any way you like. To make life easier for equipment designers, the people who design and build tubes run measurements upon their products and publish "characteristic curves" which describe the key factors.

A typical characteristic curve for a triode (Fig. 8) graphs plate current against plate voltage for various values of grid voltage. A not-so-typical curve might graph plate current against grid voltage, for various plate-voltage values. For most designers' purposes, though, the plate-current/plate-voltage curve is best, so it's the one most often supplied.

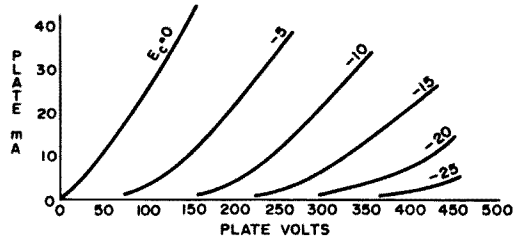


Fig. 8. Typical set of plate-voltage/plate-current curves for a triode tube shows relation of plate milliamperes to plate volts for six selected values of grid voltage. Relationships for other grid voltages must be interpolated between these, if they are needed.

However, if we know plate current and plate voltage at any instant, then by Ohm's Law we can determine the effective plate-to-cathode resistance represented by the tube.

If the tube's plate is working into a reactance rather than a resistance, as for instance the primary of a transformer, or a choke-coupled output circuit, the plate voltage averages out to be constant and the manufacturer's curves can be used as they are. Changes of grid voltage then change only plate current.

If the plate works into a resistor, as in a resistance-coupled amplifier, it's a bit different and the picture gets messier. A "load line" must be drawn on the curve to determine the dc plate voltage present at any instant.

By using the curves, together with his accumulated training and experience, the equipment designer picks an "operating point" for the tube by proper choice of the plate and grid voltages, so that the change in grid voltage will cause a corresponding change in resistance between plate and cathode. That is, if a 0.5V increase in grid voltage causes a 10% drop in resistance, a 1V increase of grid voltage should cause a 20% resistance drop and a 1V decrease at the grid should result in a 20% increase of resistance. These figures are, of course, merely examples and do not correspond to any actual circuit.

When this had been done, the result is a circuit which produces for its output an "amplified" or stronger version of the input signal. The "linearity" of amplification is a measure of how accurately the output follows the input; another phrase used for the same effect is "distortion."

Notice particularly that this same process occurs in any kind of amplifier based on tubes or transistors, no matter what the circuit's name may be. Class A, B, or C amplifiers, as well as grounded-grid,

grounded-cathode, and cathode-follower circuits, all act on this same basic process.

The terms "class A," "class B," and "class C" describe the operating point of the circuit. A "class A" circuit is intended to produce low distortion, and to give an output which is a faithful replica of the input. A class B circuit's operating point is much closer to the cutoff point (a true class B circuit operates exactly *at* cutoff); output is distorted but efficiency is higher. A class C circuit remains cut off most of the time and passes current only during the peaks of the input signal. Output is distorted beyond recognition but efficiency is highest under these conditions. Since the distortion can be removed from a continuous (unmodulated) rf signal by a resonant circuit, class C amplifiers are used for rf.

As we have already learned, any circuit requires two conductors to complete it; we can think of one as the "hot" lead and the other as a "return" path for the current. The usual "return" past in most radio equipment is the chassis, which we refer to as "ground" or "common" since it is often connected to ground, and provides a common return for all signal paths.

Our vacuum tubes, with their associated components, convert an input signal into an output signal. This means that four conductors are involved, two for each signal. The return for each signal, however, is almost invariably grounded, which reduces the number of conductors to three – an input "hot" lead, an output "hot" lead, and ground. This is fortunate, since a triode tube has only three elements; we have exactly enough conductors to assign one conductor to each element; with neither elements nor conductors left over.

Because of the physical means by which the tube does its job, the input *signal* must be applied between grid and cathode, and the output signal must be taken from plate and cathode. However, this does not necessarily mean that the cathode must be connected to ground, input to grid, and output to plate.

While it's true that the most conventional use of tubes follows just that assignment (called grounded-cathode operation), we can connect our common ground to any one of the three elements (Fig. 9). If, for instance, we ground the grid, then we must apply the input between cathode and ground. In order to take output with only one wire at the plate, we must pass all the output current through the input circuit. That is, since the input is connected to the cathode, the output signal's path must go through the input to get to the cathode in order to reach the plate.

Similarly, we could ground the plate. The input signal is now applied between grid and plate, while the output signal is taken from cathode and plate. For the input to get to the cathode, it must travel through the output circuit.

This means that in both the grounded-grid and the grounded-plate (usually called cathode-follower) circuits, the input and output circuits are directly connected. In the grounded-grid circuit, they are in series, so that all the current of one must pass through the other, while in the cathode follower, they are in parallel, so that the voltage of one becomes the voltage of the other.

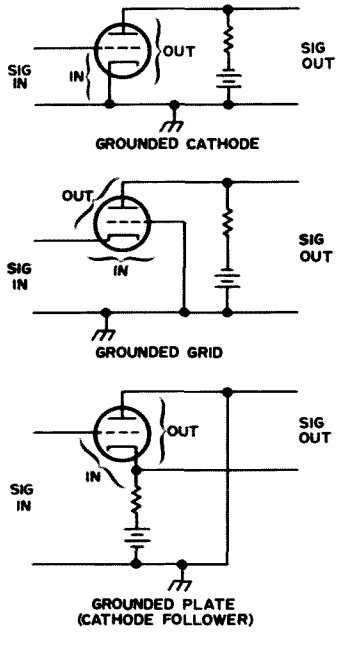


Fig. 9. Differences between the three ways of connecting tubes in amplifier circuits are shown here. These are simplified schematics and leave out all the necessities such as grid bias, coupling capacitors, etc., to emphasize the similarities and differences of the three different circuit types.

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In the conventional grounded-cathode circuit, the input and output circuits are isolated and do not interact so directly.

The apparent differences between these three different circuits are due primarily to this difference in relationships of input and output signals. In the grounded-grid circuit, a small input voltage causes a large change in plate current – which forces a large change in input current because of the series connection. This makes the circuit look like a low impedance to its input, and a very high impedance to the output. It also permits feedthrough of power from input to output.

Since it's voltage rather than current which interacts in the cathode follower, the effects are reversed. Input impedance is very high, and output impedance is very low. Coupling of signal from input to output is small; voltage gain is always less than 1, which means that a cathode follower actually introduces a voltage loss.

The gain of any individual tube is determined by the internal geometry of the tube, together with the applied voltages and currents. If voltages and currents are the same, the tube must provide the same gain in any of these three circuits. The stage, however, need not deliver the same gain.

For instance, a conventional grounded-cathode amplifier has its input and output circuits separated and minimizes interaction between them. In such a circuit, the stage gain can approach the maximum of which the tube is capable. Both the current and voltage of the input signal can be made larger in the output.

A grounded-grid stage, however, has its input and output circuits in series, so that the output current and input current must always be the same. Its gain can affect only the signal voltage. Thus the current gain of the grounded-grid amplifier cannot exceed 1, but high voltage gain is possible. While the gain of the tube itself remains high, the interaction between input and output signals outside the tube reduces stage gain.

The cathode follower has its input and output circuits effectively in parallel, so that the voltage in an;out must be approximately the same. Its gain can affect only current. Voltage gain cannot be greater than' 1, but high current gain is possible. Again, the tube gain is unchanged, but the input/output interaction outside the tube provides the restricting factor.

Since both the grounded-grid and the cathode-follower circuits produce less gain than does the grounded-cathode arrangement, and since amplifiers are usually intended to produce gain, this gives rise to the question "Why use these inefficient circuits?"

Each of them has its own unique properties, which provide certain advantages in special situations. When the properties are not needed, the special circuits aren't used.

The grounded-grid amplifier reduces the stray coupling between input and output circuits inside the tube, because the grid acts as a shield between cathode and plate. This makes it possible to avoid having to "neutralize" a high-frequency amplifier, and in some cases makes it possible to operate a given tube at a higher frequency than would otherwise be possible (by modifying the effect of the built-in "low-pass filter" we examined earlier).

In addition, the low input impedance of the grounded-grid circuit is often convenient for a high-power rf amplifier, and the capability of feeding through power from input to output is also nice (although no longer offering a loophole in the FCC regulations).

Contrary to popular opinion, there is no appreciable difference in amplification quality between a grounded-grid amplifier and one using the conventional grounded-cathode circuit. Quality in each case depends upon proper adjustment of operating point and input signal level, not upon the choice of the common electrode.

The cathode follower's special properties depend upon its high input impedance and low output impedance. This makes it ideal for use in transforming impedances from high to low levels. The input capacitance is reduced by the same factor that input resistance is increased, making the cathode follower an excellent device for coupling energy out of critical circuits such as rf oscillators. The low output impedance makes it capable of driving a feedline without any intervening transformer, although other factors make this idea less attractive than it may sound at first.

The cathode follower offers an ideal example of "feedback" in action; this is an important idea in all electronics, and seldom appears so clearly illustrated as in the cathode follower. Let's take a conventional grounded-cathode circuit and change it, step by step, into a cathode follower to see how feedback provides all the special characteristics of the cathode follower while the tube itself continues to operate just as it did before.

We'll start with an imaginary triode which operates normally with a plate-to-cathode potential of 100V, a cathode-to-grid potential of 5V, and a plate current of 10 mA. Under these conditions, with a 10 kΩ resistor as its load, the tube provides a voltage gain of 21 times (Fig. 10). That is, a 0.1V change in grid voltage will change the plate current by 210 μA, causing the plate voltage to change by 2.1V. A 1V change in grid voltage will change plate current by 2.1 mA, causing a plate voltage change of 21V.

Now let's move 1 kΩ of the plate load resistor around to the cathode circuit, leaving 9 kΩ in the plate lead (Fig. 11). This 1 kΩ in the cathode circuit is in both the cathode–grid circuit and in the plate–cathode circuit, so that the plate path still sees 10 kΩ.

If we change the grid voltage by 1V, the plate current will change by 2.1 mA. This will increase the cathode voltage by 2.1V (if the grid is going positive so that the current increases) and decrease the plate voltage by 18.9V. The plate–cathode voltage change is still 21V. The output voltage change would be less than that, however.

Unfortunately, the 2.1V change in cathode voltage is of such a polarity as to *reduce* the effect of the 1V input signal; were the entire 2.1V increase to occur, it would completely cancel the input signal

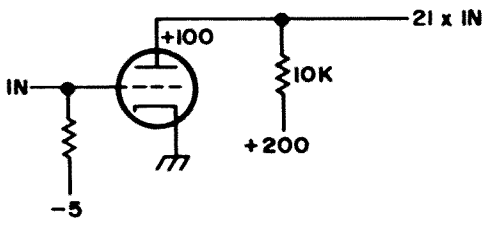


FIG. 10

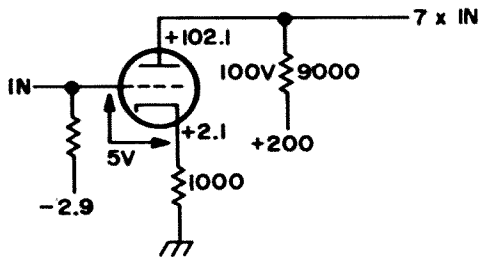


FIG. 11

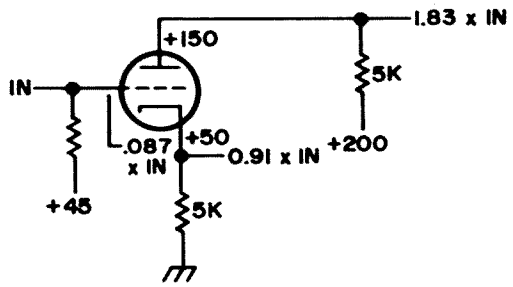


FIG. 12

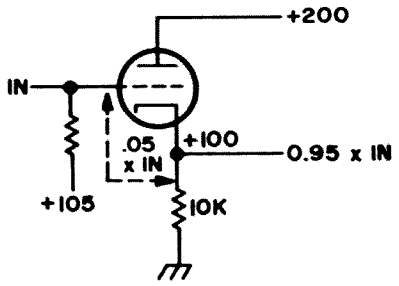


FIG. 13

Figs. 10–13. These four schematics illustrate how feedback introduced by resistance in cathode circuit reduces stage gain although tube itself continues to operate unchanged. Voltage applied to grid maintains grid-to-cathode voltage at 5; as cathode voltage changes, grid voltage is changed to always be 5V less.

which produced it. This, of course, cannot happen. What does happen is this:

The *effective* input signal is the one between grid and cathode, while the actual input signal is between grid and ground. When the grid voltage goes up 1V, it cannot do so instantly but must increase a few millivolts at a time. As it does so, the cathode voltage comes right along behind to buck it – and at some point they meet and level off so that 1V applied between grid and ground produces a grid-to-cathode voltage just right to permit the cathode-to-ground voltage at that instant.

In our example, this will happen when the grid–cathode voltage is a little higher than 0.322V. The cathode current increase caused by this voltage is a little more than 0.67 mA, and the rise in cathode voltage is about 0.676V. The two voltages add up to 0.998 – which would have been 1.0 except that we rounded off our figures.

The "feedback" voltage appearing across the cathode resistor, then, reduced the effective input voltage to a smaller value. This in turn reduces the output signal voltage, since there is less input signal available to the grid. Stage gain is reduced – but the tube itself is still providing a 21-time voltage gain.

Input resistance of the stage increases, because resistance is defined as voltage divided by current (Ohm's Law). Only the effective input voltage sees the original stage input resistance, but the entire input signal is affected. This means that the original input resistance must be multiplied by the same value that the voltage is divided by in order to keep current constant. In our example, the effective voltage is about a third of the actual voltage, so the effective input resistance is three times that of the original circuit.

Now let's move some more of the resistance from the plate circuit to the cathode (Fig. 12). This time, let's make it 50/50, with 5 kΩ in each.

The feedback causes the effective signal input voltage to be smaller than the actual input, just as before, only more so. Where in our first example the cathode voltage rose 2.1 for every volt increase in grid–



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cathode voltage, it will now rise 10.5 because of the greater resistance.

Effective stage gain under these conditions is reduced from 21 times to about 1.83 times. That is, a 1V input signal from grid to ground will produce an apparent 1.83V change in plate voltage – which means a 183 μA change in plate current.

This means that the increased cathode resistance caused the leveling-off to occur with an effective input voltage of only about 0.087V. The remaining 0.913V of the input signal was bucked out by cathode voltage.

Input resistance, similarly, is much greater now.

If we move all 10 kΩ over to the cathode circuit (Fig. 13), we find that effective stage gain is down to 21/22. That is, a 1V input signal will cause a 0.954V change in cathode voltage. The effective input between grid and cathode, then, is only about 0.05V. The tube is still producing its 21-time gain, because 0.05 times 21 is 1.05 (actually the input is a little less than 0.05, providing 0.95V out). Input resistance is now 21 times larger than originally.

The cathode follower circuit we have just developed can accept much larger input signals than could the grounded-cathode circuit with which we began. For instance, we had a 5V bias on the grid at the beginning, which meant that any input signal more positive than 5V would carry the grid positive (a condition to be avoided in most cases). With the approximate 20-time division of actual input voltage produced by the cathode follower's feedback, a 5V input signal is effectively reduced to 0.25V, and even a 20V input signal is effectively cut back to 1V from grid to cathode.

Where originally we ran out of the operating range with a 5V signal, we can now go up to a 100V signal without exceeding the same operating limits.

This is not the only advantage produced by controlled feedback. The changes in input and output impedance are also due to feedback's modification of effective voltage and current levels. Not so obvious is the fact that any distortion introduced by the tube is reduced, because it is *not* a part of the original input signal.

The grounded-grid amplifier's characteristics of low input impedance and high output impedance are also the result of feedback; in the grounded-grid circuit, it is current that feeds back rather than voltage, and this reverses the effect upon impedances.

Feedback also makes oscillation possible, if the feedback voltage boosts the input signal rather than bucking it. We'll go into all this in another chapter, however, when we examine practical amplifiers and transmitter circuits.

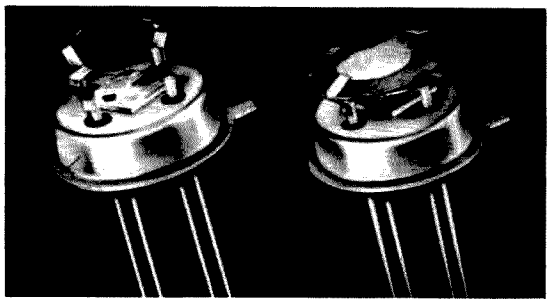
A Place to Start

By this time, we've fairly well covered the basic components and ideas upon which electronics and radio theory are built. With our foundation established, we're ready to begin putting things together into operating circuits. One thing which any circuit must have is a source of power, so the power supply is a good place to begin our study of practical circuit theory. . . . Staff ■



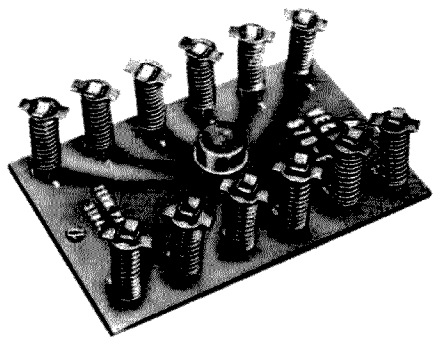
NEW PRODUCTS

Crystal-Controlled Microcircuit



A crystal-controlled microcircuit oscillator (Model MCO-F), which uses thin-film capacitors and resistors on a single substrate, is totally contained within a 4-lead TO-5 Koldweld package. The new unit is designed for application as the local oscillator or second mixer in dual-conversion receivers. It is especially suited for use in advanced paging and personal portable receivers where rugged environmental conditions may be encountered. *TRW Electronics, 1100 Glendon Ave., Los Angeles CA 90024.*

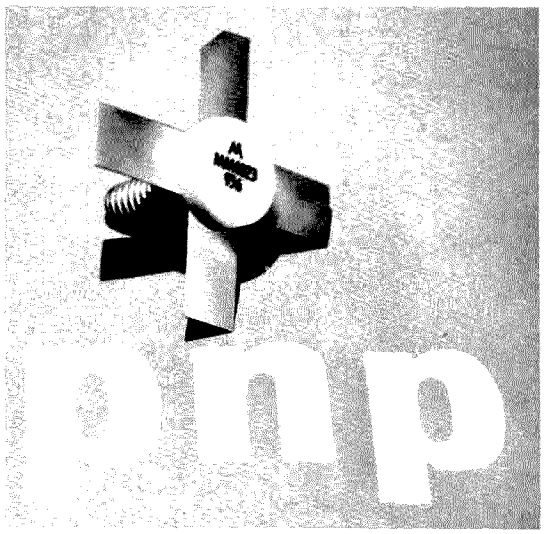
IC Breadboard Socket



A new device is now available for breadboarding with 12-lead, round TO-5 integrated circuits. The device consists of an epoxy glass wafer, 2-3/8 x 1-5/8 in., on which is mounted a 12-pin socket, the tabs of which have been soldered to two adjacent rows of reliable solderless terminals.

The device should speed IC breadboarding because as many as four solderless connections can be quickly made to any terminal pin with ordinary hook-up wire. If discrete components are required, they may also be easily connected. *Vector Electronic Co., 12460 Gladstone Ave., Sylmar CA 91342.*

Power Transistor Line Expanded



Four new transistors have been added to the industry's only line of silicon PNP rf power devices. The transistors, types MM4020 thru MM4023, bring to nine the number of devices in Motorola's PNP rf power family and increase the variety of output powers available to the designer. These now range from 0.5W to 40W @ 175 MHz.

Each of the transistors features balanced-emitter construction for maximum safe operating area, isothermal design for flat power output versus temperature performance, and low lead inductance stripline packaging.

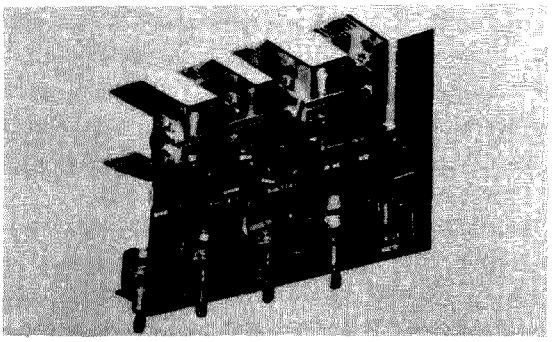
The transistors are designed for the 12.5V VHF large-signal amplifier amplifications required in military and industrial equipment operating at frequencies up to 250 MHz.

In the unusual construction used for the four new transistors, thin-film Nichrome resistors in series with each of the multiple emitters distribute power evenly throughout the chip. This technique prevents "hot emitters" and results in maximum safe operating area and a rugged device that

stands up under the high voltage standing wave ratio conditions sometimes occurring in a mistuned rf system.

The MM4020/21/22/23 transistors bring another important characteristic to the rf designer – exceptional output power stability versus temperature – through the use of isothermal design. This type of transistor design insures the even generation and flow of heat in and from the chip so that the "power slump" usually encountered in an rf power device operating near its maximum frequency is nearly absent. *Motorola Semiconductor Products Inc., Box 20924, Phoenix AZ 85036.*

Amplifier Modules in Semi-Kit Line

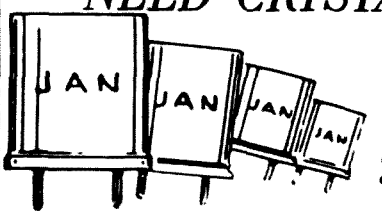


Eight different special and general-purpose audio amplifier modules are being offered by GC Electronics Division of Hydrometals, Inc., as part of its new Calectro-Amperex line. Basic module shown here is a 20-watt stereo amplifier, which is blister-packed and displayed on a pegboard rack. The line also includes lower-power hobbyists' amplifiers and guitar amplifiers, along with a professionally finished universal chassis/cabinet kit. *Ivens Stanton Assoc., 122 East 42nd St., New York NY 10017.*

Miniature FM Mobile Unit

The Regency solid state Model HR-2 features a 10W of rf power output with operation on any of 12 transmit and receive channels. The receiver section of the new radio is double conversion, superheterodyne with a highly selective ceramic filter for operation on both wide and narrow band signals. Sensitivity is rated at 0.35 μV, 20 dB quieting. The transmitter features phase modulation for exacting

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carrier stability. Individual trimmer capacitors enable frequency netting for optimum performance in point-to-point or repeater applications. Built-in swr load mismatch circuitry protects against open or shorted antenna conditions.

The 2¼ x 5½ x 7½ in. package comes complete with plug-in ceramic microphone, built-in speaker, and mobile mounting bracket. One pair of factory installed transmit and receive crystals on 146.94 MHz are included in the $229 amateur net price. *Regency Electronics, 7900 Pendleton Pike, Indianapolis IN 46226.*

High Power on 450 MHz!

Requiring only 8–10W of rf input power, the Alpha PA-100 UHF amplifier will achieve a power output of 100W. Designed for fixed base station or repeater use in the 450 MHz band, this compact unit has a self-contained solid-state power supply, no electromechanical moving parts, and requires only 5¼ in. of rack space. The true integrated coaxial plate cavity construction assures high plate efficiency and low plate operating temperature, making possible continuous-duty use while assuring long component life. The grid input circuit works to suppress harmonics generated by the input transmitter, thus reducing the problem of intermod. The PA-100 is said to be easy to install and is ideal to upgrade existing low-power repeaters or base transmitters. *Alpha Electronic Services, 8431 Monroe Ave., Stanton CA 90680.*

High Power on 2 FM

The new "22'er FM" by Clegg features 60W of rf input power plus a highly sensitive TUNABLE receiver. Ten crystal-controlled channels are available for transmit. Made in the United States. *Clegg Associates, Inc., Littell Road, East Hanover NJ 07936.*

Solid State Transmitter-Receiver

Another 2 meter FM transceiver has just been introduced to the amateur scene. The unit sells for $250, has a 5W transmitter, 6-channel receive-transmit, FET front end. The i-f's and af circuits are IC, and the unit comes with two installed channels (.94 direct and .34–.94). A front panel meter indicates signal strength and rf output relative power. Price includes mike, bracket, and dc power cable. *Telecomm, Box 461, Cupertino CA 95014.*

Phase-Locked-Loop Linear IC

Two new "phase-locked loop" linear integrated circuits are ideally suited for such applications as accurate multiplication and division of frequencies virtually in any ratio, according to *Arthur E. Fury, Manager of Linear Product Marketing.* Range of operation extends from subaudio frequencies to VHF.

"These units are unique in the industry," Fury said, "because they are designed to perform mathematical functions that are quite impractical with digital circuits. Our devices can multiply, divide, and even fractionalize frequencies virtually in any ratio. For example, they can divide a fundamental frequency by 10/3, if desired, a process which is virtually impossible with digital devices."

Operating range of the 562, a model of the device fabricated with a dielectric isolation process, is 0.1 Hz to more than 50 MHz. The 562 chip is 67 by 75 mils in size. Signetics engineers designed the two new phase-locked loop circuits in direct response to comments received on the first PLL linear circuits which were introduced by the company several months ago. "We have added a number of features," Fury said, "which makes the phase-locked loop more useful for specific applications. Most important among the features is that we have opened the loop and provided connections that permit the insertion of external devices into the loop circuit."

Four separate sections comprise each device: a phase comparator that also operates as a multiplier and mixer, a low-pass filter, an error-signal amplifier, and a voltage-controlled oscillator. The loop circuit has been opened between the VCO and the phase comparator.

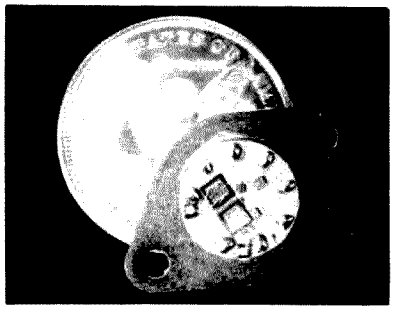
Additional information is available from *Signetics Corp., 811 East Arques Ave., Sunnyvale CA 94086.*

Low-Harmonic High-Power Linear

Raytrack Company of Columbus, Ohio is introducing its new lowband linear amplifier, the DX2000L. This amplifier has an input capability of 2 kW PEP SSB, and 1 kW AM, CW, and RTTY, and is for operation on the 80–10 meter bands. The DX 2000L is the first high-power linear amplifier to use a hybrid tank circuit (Raytrack's unique toroid and air inductor combination). This system gives the DX2000L extraordinarily high efficiency on all of the 80–10 meter bands, and, in combination with the pretuned toroid input makes this amplifier far less prone to radiate TVI, according to the manufacturer.

Two zero-bias triodes (EIMAC 3–500Z) are operated in class B and are preneutralized for maximum stability. Other features include: an adjustable alc output (negative feedback) that is compatible with all standard equipment; an exciter feedthrough that eliminates the need for additional relays to operate the exciter only; *precision* taut-band meters; and a very handsome case. The DX2000L has a separate power supply that is included in the price. *Raytrack Co., Columbus OH.*

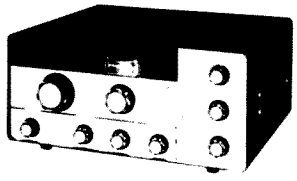
Hybrid Power Amplifier



TRW Semiconductors announces the addition of the HMD 2000 hybrid power amplifier to their microelectronic product line. This amplifier can be operated in either a linear or switching mode with capabilities of delivering 3A peak current for power supplies to ±25V. Mounted in a TO-3 package, it is ideal for a broad range of applications including switching; class B servo; hi-fi audio amplifiers, and motor drivers. Power amplifier is priced at $10.50. *TRW Semiconductor Div., 14520 Aviation Blvd., Lawndale CA 90260.*

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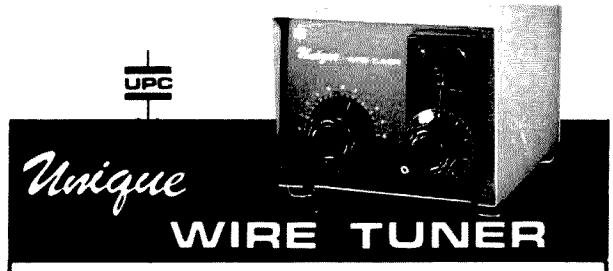
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Yipes, It Talks!

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I shall never forget one Hallowe'en, long ago when I was a neophyte in electronics. My dear old grandmother, God rest her, came into the parlor ready to settle down with a good bloody murder mystery. It was quite late and the whole family, she thought, was sound asleep. She switched on the light.

"Good evening."

Grandma jumped back. Then, getting a grip on her nerves, she quickly checked the closet, looked under the couch and behind the curtains. She was quite alone in the room.

"What 'cha looking for?" It seemed to be coming from the coffee table. An old newspaper lay innocently on the table. Grandma adjusted her glasses, bent over the table and scrutinized the paper. She was breathing rather hard.

"Lady, you really ought to do something about those adenoids."

Grandma jumped back as if she had seen a rattlesnake. "It talked," she gasped, "The d——thing talked!"

"So, what's wrong with that? Do I get all shook up when you talk?"

Grandma was completely befuddled by now. The last remaining black hairs on her head had just turned snow white. Then a strange thing happened. She shrugged her shoulders, set her mystery aside, and began to talk. Of course she never told anybody about the conversation, but she confided with the newspaper that she hadn't had such an enjoyable conversation in ages. The two of them chatted together until the wee small hours.

I never had the courage to confess to Grandma that I had been the culprit. A few times after that, when she thought she was alone, she tried to strike up a conversation with other newspapers, but none of them were anywhere near as sociable as that Hallowe'en issue.

Since I've already mentioned that I had been the culprit, you've probably guessed that there was a loudspeaker concealed in the room. Not exactly. The secret really lay in the newspaper. If grandma had picked it up, she'd have caught on right away. Fortunately for me, she was far too polite to lay hands on her guest.

It's really a pretty simple thing to rig. All you need is a copy of the Daily Dirt and a package of aluminum foil. Open up a full sheet and spread a strip of the foil inside it. Fold the sheet over and lay another strip of foil on top. When you fold the sheet again, if you've done it right, the foil should be completely concealed and the paper should look the same as it did when it was on the news stand. The two pieces of foil should be insulated from one another by the paper. In other words, the whole business should look like a big capacitor. The next step is to wire it up, but before we do, let's take a look at how and why it works.

I said before that it is a big capacitor. I can qualify that slightly and say that actually it is an electrostatic loudspeaker. The

audio signal is impressed between the two foils. Since two oppositely charged objects attract each other, and since the audio signal consists of a varying voltage, there is a

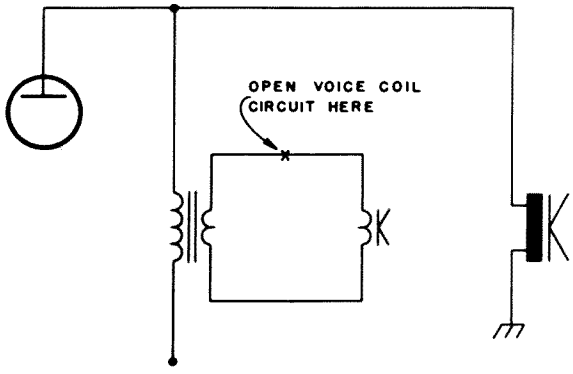


Fig. 1. Method of connecting electrostatic speaker to vacuum tube output.

varying attraction between the plates. The plates, in this case the foils, will therefore vibrate and reproduce the sound.

When I first rigged up this demonic device, solid state equipment was virtually unheard of, so I simply connected one foil to the plate of my final amplifier tube, and the other to the chassis. Electrostatic speakers work best when the audio is riding on top of a high dc voltage. This polarizing voltage, as it's called, was neatly provided by the plate supply voltage which was there anyway.

Nowadays most audio equipment is solid-state. Since solid-state operates under very different conditions, you will now have to artificially duplicate vacuum tube conditions. An electrostatic speaker, you see, is a very high impedance device, and so it must be fed with a high voltage signal from a high impedance source. You can meet this requirement by connecting a small output transformer in reverse. That is, the voice coil winding connects to the output terminals of your amplifier. The plate winding connects to the foils. A polarizing voltage of a hundred volts or so can be supplied either from a rectifier or from a battery, the capacitor, C, providing a path for the audio voltage.



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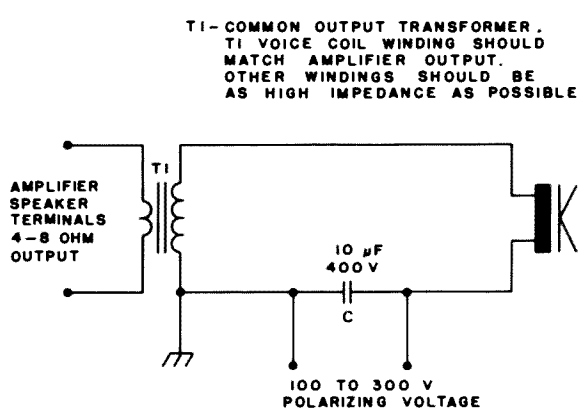


Fig. 2. Method of connecting electrostatic speaker to output of solid state amplifier.

Even if you do not have a sweet old grandmother to bug with this tomfoolery, it can still be an excellent party gag, and I know of no better way to have your best friends tag you as an absolute unmitigated nut.

. . . W2FEZ

REGENCY

an FM Late Starter

. . . could be a front runner!

Ken Sessions K6MVH

I have nothing but praise for Regency's new HR-2 miniature multichannel all-transistor 2 meter FM transceiver. This is far and away the best buy in American-made amateur FM units. It's priced right, it performs right, it has a very respectable output power, and it is one of the smallest units obtainable. And it has some very desirable features that none of the other manufacturers have thought of yet.

Of all the good points, the price itself is the most impressive. At $229 there should

Manufacturer	Model	Price ($)	Channel Combinations Available	Total Xtals T	Total Xtals R	Mfr Loc	Xmtr Pwr Out (W)	Rcvr Sens (μV - 20 dB)
Regency Electronics	HR-2	229	12	6	6	U.S.	10-12	0.5
Galaxy (Hy-Gain) (w/power booster)	FM-210	230	9	3	3	U.S.	2.5	1.0
Telecomm	FM144-10F	250	6	6	6	U.S.	10	0.5
Varitronics (Inoue)	FDFM-2S	270	6	6	6	Jap.	10	0.8
Standard	SR-C806M	349	12	12	12	Jap.	10	0.5
Varitronics (Inoue)	IC-2F	349	36	6	6	Jap.	12-15	0.4
Clegg Associates	22'er	400+	Tunable	10	0	U.S.	30	0.4
R.L. Drake Co.		329	12	12	12	Jap.	10	0.5

be no reason at all for any VHF enthusiast to put off going to FM any longer. You're just not going to get on 2 meters FM in style for anything less.

Now let's take a look at what you get for that $229:

How about power? The Regency HR-2 runs between 10 and 12 watts *output*. The Motorola transistor that the Regency unit uses in the final rf amplifier is guaranteed to crank out at least 10 watts, and the people at Regency are making sure that each unit produced meets or exceeds that specification.

Deviation level. When the Regency leaves the factory, the deviation is set at 10 kHz. Since this is a little much for the New England repeaters, I had to crank our test model down to about 7 kHz. The deviation can be adjusted anywhere from less than 5 to slightly more than 15 kHz with an easily accessible pot inside the rig. The unit comes with microphone, too, by the way – and from reports of the local repeater groups, the audio is exceptionally clean.

What about the receiver? The receiver is a dual-conversion superheterodyne type with six-channel capability. It is relatively broad-banded, requiring no peaking on individual channels in the 2 meter range. A ceramic filter in the second i-f stage gives adequate selectivity for most metropolitan areas, even where adjacent channels are active.

If you buy this rig and later decide to add crystals, you've got to be a bit choosy as to where you buy your rocks. The HR-2 has no means of rubbering "receive" crystals onto frequency; if the crystals are off, your receiver will be off. The people at Regency say nobody will ever have trouble if they order from Sentry Manufacturing Company (Oklahoma), International Crystals (Oklahoma), or Shepherd Industries (Kansas). To my mind, the lack of

Accessories Included in Purchase Price	Extras You Must Buy	Comments, Special Features	Problems, disadvantages
Microphone, power cord, mobile mounting bracket, crystals for 146.94.	None	See text	No meter; no receiver rubbering capacitors.
Power plug.	ALL	Power booster supplies 24V dc to final transistor to bring the rf output up to 5W. (costs $50 extra).	No accessories, no meter, unstable rubbering capacitors.
Mike, mobile mounting bracket, power cord, crystals for 146.34 and 146.94.	None	Panel meter for rf out & signal strength.	Test unit did not meet specs.
Mike, mobile mounting bracket, power cord, crystals for 146.34 and 146.94.	None	Illuminated panel meter for rf out & signal strength in.	Antenna connector makes sloppy fit to VHF connector.
Mike, mobile mounting bracket, power cord, crystals for 146.94.	None	High/low power switch; illuminated panel meter. Add-on amplifier avail.	Squelch and volume controls too tiny for easy mobile operation.
Mike, mobile mounting bracket, power cord, crystals for 146.34 and 146.94, antenna connector, spare fuse, connector for optional external speaker. Discriminator test socket and plug.	None	Panel meter illuminated white on rcv, red during transmit. Meter indicates S-units and rf out. Freq selector switch is concentric so xmit and rcv channels are independently controlled.	
Ac/dc power supply, microphone, power cords for ac and mobile operation.	None	Built-in ac/mobile power supply.	Tunable receiver. Too large for mobile use. Tube-type transmitter final.
Mobile antenna, coax, mobile mount, mike, ac/dc pwr splys.	None	Built-in ac/mobile pwr supply. Extremely selective & stable rcvr.	Transmitter has vacuum-tube final.

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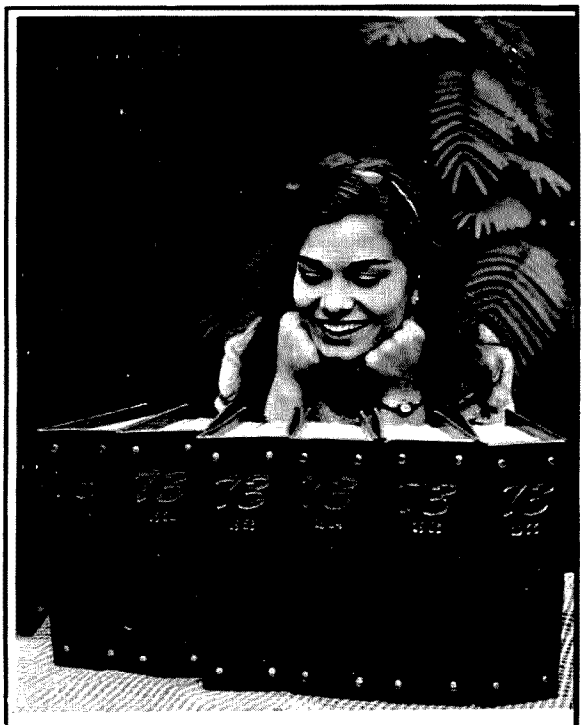
Electromechanical Devices for Energy Conversion and Control Systems, by Del Toro
Published at $25. Limited supply at $10. Hardbound, 617 pages.

tweaking ability on the receiver is a distinct disadvantage – but it is overshadowed by a considerable margin when I consider the unit's sales price.

Special features? The most useful single feature of the HR-2 is its multiplicity of transmit–receive combinations. There are six crystal positions each for the transmitter and the receiver, but a twelve position switch is used for selection. The first six positions on the switch (numbered 1 through 6 on the faceplate) select the six crystal positions, and the next six positions on the switch (labeled A through F) can be used to select specific combinations of the various crystal sets. Positions A through F are chosen by jumpering on the switch itself, so that there are a total of 12 available channel sets from only six sets of crystals.

How does the Regency HR-2 stack up? Probably the best way to determine the relative merits of the HR-2 is to compare the unit with other 2 meter FM transceivers. The chart on the preceding pages will give you an opportunity to make your own comparison and evaluate the features you consider to be the most important.

...K6MVH ■



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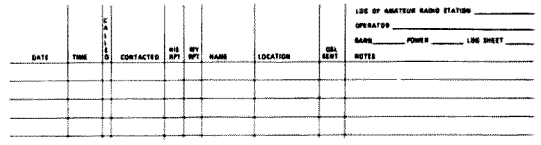
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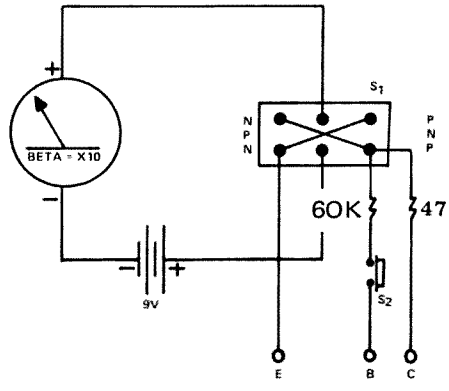
Transi-Test

Of all the various transistor tester projects that have appeared in numerous amateur radio and electronic magazines this past decade, I believe I have come up with a circuit that will outdate previous articles. Many of these projects have been designed so you may utilize a tester with your scope, VTVM, or some other gear.

This particular circuit, which I named the "Transi-Test," is designed with simplicity and is very accurate in measuring beta, leakage, and shorts. It will test any NPN or PNP transistor (signal or power). I also find it great in checking silicon or germanium diodes by using the emitter and collector leads to test for shorts and leakage. The Transi-Test is 100% portable, using a 9V battery for its power supply.

Most transistor testers employ a 4pdt switch for polarity, but this one is designed around a dpdt switch, which is easy to find at any parts store. To say the least, all the parts can probably be found in your own junkbox! I used a Premier #SPC-23 meter case to give the Transi-Test a professional appearance. The three test leads should extend 6 to 8 in. from the front of the case. For easy connection to small transistors, a micro alligator clip should be used such as the Mueller #34-C. Be sure to use an alligator insulator on the collector lead to prevent the emitter and collector leads from shorting together due to stiff test leads. This will save unnecessary battery failure.

If you do transistor servicing quite frequently, it is advisable to use a toggle switch (S1) which will last indefinitely. The only holes that have to be drilled in the case are for the three test leads, using rubber grommets. The SPC-23 meter case is already prepunched for the meter and two switches, which is why I happened to choose this particular one. Bud Radio also manufactures a case identical to this one.



After completion of this small project, you can rummage through your junkbox and start identifying those "lost cause" transistors that have been lying dormant all this time. I'm sure you will find the Transi-Test to be a very valuable test instrument on your workbench.

Lew Christy WB6QQP ■

Never Say Die *(cont. from p. 10)*

been a strong factor in freezing the League into immobility. We cannot afford this paralysis in the 1970s. If directors were to attend four regional ARRL conventions each year (east, midwest, southwest, west) and consult the membership at open forums at these conventions, they could act immediately upon the wishes of the members. Their way would be paid to the four conventions by HQ.

Public Relations

A competent public relations firm (preferably run by an amateur) should be engaged to promote amateur radio with articles in national magazines such as Life, Look, Newsweek, Playboy, etc. They could coordinate amateur radio talent such as writers, cartoonists, and performers for maximum effect. They could help to organize ham films for television, for schools, and even shorts for movies. They could prepare strip slide shows for schools and libraries. They could prepare news releases for the papers and news services, thus making sure that amateur accomplishments reached the television, papers, and radio.

Club Material

In order to increase interest in radio clubs throughout the country the ARRL should have a wide variety of films available, covering all aspects of amateur radio operation...contests, DXpeditions, moonbounce, television, RTTY, traffic nets, mobile operation, repeater operation, etc. There are many amateurs that would be happy to work to produce films and slide shows on amateur radio subjects if only there were a central organizing effort. ARRL could provide this coordination. Films and slides can do a lot toward building club membership as any member of sports car clubs and skin diving clubs, will tell you. Amateur radio is almost alone in its lack of interesting program material for clubs. This should be a function of the League. Who else *is* there?

Outgoing QSL Service

Virtually every other national amateur radio society in the world provides an outgoing QSL service for its members sending cards to other countries. There are, as far as I know, no insurmountable problems stopping the League from providing a similar service. This should be carefully investigated from the viewpoint of finding out how to do it rather than trying to find out why it can't be done.

Legal Fund

The legal problems involved in setting up an emergency fund for helping amateurs fight lawsuits which, if lost, could seriously affect the whole amateur radio hobby should be investigated and overcome. Is there any real reason why the League should not help beleaguered amateurs in such legal fights?

Amateur Radio's Future

Satellite repeaters for FM and ATV are within the realm of technical feasibility today. The League should take the lead in planning for the future of our hobby. Even the cost of a set of satellite repeaters covering the whole world could be organized by the ARRL. Perhaps the techniques of multiplexing can be developed and applied to solve QRM problems on 20m and other crowded bands. Dialog in QST on new ideas should be encouraged.

Radio Clubs

It is possible that the role of amateur radio clubs could be expanded in the administering of exams for the FCC.Certainly the clubs could be a powerful factor toward developing new amateurs with guidance and encouragement from HQ. A monthly newsletter to provide dialog between radio club presidents and the directors might help encourage amateurs to take more interest in their future.

IARU Development

The International Amateur Radio Union, made up of the national amateur radio societies of the world and organized by ARRL could function better and provide better leadership if ARRL were to publish a monthly newsletter for all member societies. At present all that is provided, I understand, is a yearly calendar. Region 1 (Europe and Africa) periodically publishes newsletter. The amateur radio societies in the rest of the world might have more confidence in IARU if it provided some leadership and communications.

The IARU could spearhead a drive to collect older amateur radio equipment and ship it to underdeveloped nations. The shortage of equipment is one of the most important deterrents to new amateurs in these countries. India could have thousands of amateurs instead of a few hundred if only gear were available.

Unity of the IARU societies would provide unity toward the problems of the ITU and frequency allocations. Communications is the first step towards unity.

New Books

The ARRL book department should be turned upside down and cleaned out. One look at the Editors and Engineers handbook is enough to prove that a major change is needed in the production of books at HQ. The yearly ARRL Handbook changes like a glacier. Not only that, but one of life's more frustrating experiences is to try and learn radio theory from that book. This is not necessary as we showed with our license study courses.

Spend 25¢ and buy a copy of the ARRL book on "Operating an Amateur Radio Station." This publication is all too typical of League literature and is beyond description. As a director I would make every effort I could to see that those re-

sponsible for this type of claptrap were transferred to some other job.

The League has a responsibility to produce interesting and up-to-date books on every aspect of amateur radio. They should have thorough study books on each amateur exam, not memorization manuals as they do right now. They should have a definitive and continually updated book on RTTY, DX, ATV, FM, moonbounce, traffic, VHF, learning the code, high-speed code, frequency measuring, 160m, antennas, microwaves, etc.

QST can carry information on building gear, on new developments, and such, but books are needed to provide detailed information on specific interests. Obviously these would all pay for themselves.

New General Manager

Few amateurs with whom I have talked have had anything encouraging to say about their visits with the present ARRL manager. Though I don't talk with him often, I must admit that on each occasion I have found him to be as close-minded as the visitors have reported. If he were capable of doing his job we would not have the growing problems here and all over the world which he has brought upon us.

Were I to be elected a director I would try to get the other directors to start looking for a suitable manager for ARRL.

It would not be simple to find the right man for this difficult job. There are many qualifications that he should have to be worthy of consideration. But you may be sure that such a man exists and that it is important that he be found before it is too late.

What sort of man do we need for this post? As I see him, he should be a man who has devoted a good deal of his life to amateur radio. He certainly should have a record of being interested and active in several branches of the hobby...DX, TV, RTTY, VHF, FM, traffic, etc. I would expect that he has done a good deal of building and designing. I would think it strange if he had not had several articles published.

The ARRL is a $1,500,000 business, so we should expect our man to have experience in running a medium-sized business. One of the problems at HQ is mismanagement of finance. There is no shortcut to business knowhow.

Our manager is also the editor of QST, so some background in publications would be valuable. He will need this to help cut the present runaway costs of publication of the magazine. Of course he could learn about all this after being hired if you like the idea of on-the-job training at your expense.

Our man should be able to speak well in front of large groups. The general manager is also a front man for ARRL and must attend most ARRL functions as host. He would also be expected to speak for the United States at international gatherings and at the ITU.

One would hope that the manager of the ARRL was highly intelligent. Can we afford to have a mediocre brain at the head of 265,000 U.S. amateurs? And remember that he is the titular head of amateur radio worldwide. This spot calls for all the brains we can muster.

I suspect that we should also be sure that the man we choose is one with a long history of getting things done. A man's history speaks for him. If he is too wealthy he has devoted himself to wealth alone and not to other interests. Has he a wide number of accomplishments? Is he well read? Will he be interested in working for a modest salary with his major payment in achievement? The answer is simple, of course. If you ask any director of any large corporation how he goes about finding a new general manager, he will tell you that there are a number of organizations that specialize in just that. You consult one and let them find your man.

Most of the directors that I have talked with recognize that it is important for them to locate a new general manager, but they are afraid to take the bull by the horns.

Other Ideas

This is by no means the end of my ideas for improving the ARRL, but I have probably lost 90% of my readers already and should shut up. Now that I've told you some of the things I would try to do if I were elected director of the ARRL, perhaps you can encourage your own director to go ahead with some of them. Or you can work to get a director elected that will do what you want.

73 at Boston

The ARRL National Convention hit Boston in the fall this year, providing a splendid display of New Hampshire foliage for those interested in beauty.

When I got word from the convention committee that no one from 73 would be permitted to speak at any convention function, I made arrangements to hire an auditorium room in the hotel to provide forum space for those interested in FM, repeaters, ham politics and my slides of Jordan taken just before the civil war there.

In 1969 we took along an international Crystal microwave oven and cooked some New Hampshire hotdogs as a feature of our exhibit. This was popular, but I didn't want to repeat so we decided to have some freshly squeezed New Hampshire apple cider along with fresh home-made New Hampshire donuts this time.

On the Friday afternoon before the convention we went up to Hancock (N.H.) and helped Joe Quinn run off almost 30 gallons of the best apple cider you ever tasted. Early Saturday morning we stopped by Crane's Bakery in Jaffrey (N.H.) and picked up 73 dozen old-time New England donuts. None of those machine-made crullers for us! There wasn't a really round one in the bunch.

We served the cider and donuts all day Saturday in between slide shows, forums, and talks in our auditorium room. By the way, one really outstanding show was put on by George Pataki YO2BO, showing slides of visiting DX hams and his recent visit to DX'ers in Europe.

To those who have written to thank us for the feed and the programs, we hereby acknowledge your notes and want you to know we appreciate your thoughtfulness.

A Look Around 73

In looking at last year's staff picture we see several absentees, alas. Two of our gals left to get married, and a third left to work with her husband who started his own business.

We've had some interesting replacements for the dear departed, starting with Nancy, who was with us back in early 1970, but had gone off to seek her fortune in Colorado, and returned, she's not sure why. Nancy puts together most of the ads in each issue as well as laying out many of the articles. Jan, the other gal in the art department, does most of the rest of the articles. In her spare time Jan is an outstanding artist, joining Lin out in the 73 art studio afternoons and weekends.

Ken Sessions (K6MVH) has added a new dimension to the editing of 73, as well as an almost undetectable tendency to favor FM articles. Ken is responsible for the new arty look of the articles in 73.

Taylor Sage joined us recently and does just about everything that we can't get anyone else to do, from supervising the maintenance of the HQ building to keeping our recalcitrant machinery running. His wife Gigi handles the bookkeeping.

In our print shop we have Jeff Parsons and Biff Mahoney, who run our three offset presses, turning out local job work as well as office forms, advertising letters, and stuff like that. 73 is printed in Wisconsin, not here, but we do have complete facilities for smaller printing jobs and turn out our books right here.

Nixon Letter Reprints

Several clubs have called and written asking for bulk copies of the October 73 Action Coupon addressed to President Nixon. This coupon requests an investigation of the recent increase in license fees for radio amateurs. If you would like reprints of this page just send a self-addressed stamped envelope to 73, Peterborough, N.H.03458 and indicate how many reprints are desired.

Ham Bumper Stickers?

Several readers have suggested that bumper stickers be made available for amateurs. Since we have dandy facilities for printing up bumper stickers here at 73 we are all for the idea. But what do you want on the stickers? We are open for any clever suggestions. The only sticker we have seen so far is BAN THE HAM, and that doesn't seem appropriate.

73...Wayne■

Leaky Lines *(cont. from p. 14)*

season, but who lapse into a state of sudden paraplegia when any mention of the FCC examination is made. They remind me of some unnamed soldiers of my acquaintance, who, never having served overseas in World War II, wore some unauthorized ETO, Asiatic Theatre, Persian Gulf Command or Purple Heart ribbons on their tunics when they went out on dates with young and impressionable (or old and impressionable) females.

I know that I am running the risk of falling into disfavor with the 35,000 odd Conditionals when I say this, but I feel strongly that some changes in this situation are long overdue. Perhaps I am being unduly harsh toward the Conditionals, but ever since the implementation of Incentive Licensing, I think most of us tend toward a less permissive and less tolerant attitude concerning all "something-for-nothing" advocates.

I am already considered *persona non grata* among large numbers of Techs who objected to my published views with respect to the granting of a portion of ten meters on an exam-free basis. They labeled me with every pejorative in the book, and with a few even I had never heard before. And I suspect that this new call to sanity will place me squarely in the path of the "slings and arrows of outraged Conditionals." So be it. Might just as well be hanged for a sheep instead of a goat.

I truly believe, and I am confident that many share my view, that all classes must somehow be drawn into the vortex, the mainstream if you will, of the present context of licensing. Operating a ham station is a privilege, not to be taken lightly. Any preferential exceptions to the standards which are now being demanded (intermediate in difficulty though they may be) constitutes a very real disservice to all those who have been compelled to upgrade in order to maintain their allocations. Unless all amateurs are governed by identical rules and regulations, subject only to *legitimate* exceptions for *valid* reasons, the entire Incentive Licensing structure becomes an empty mockery.

Simply stated, I am calling for the abolishment of the Conditional class license. Now, hold on a minute . . .I didn't say I was calling for the delicensing of Conditionals, but merely for the retirement of the category. I have thought for a long time that the designation "Conditional" implies by its very name a type of second class status, carrying a certain stigma with it. Since the privileges of the class are identical with the General ticket, the only reasons why it is maintained are: (1) the holder is physically handicapped, or (2) he lives in an area so far removed from an exam point that a journey thereto would consittute an unreasonable hardship, hence has not taken the customary FCC administered exam. He has, however, attested to his proficiency in the required tech-

nical elements, by taking an exam by mail, supervised by a volunteer examiner. In all other respects the grade of license is not distinguishable from the General license. Why then must he be given this appellation "Conditional"?

An apt analogy is that of native born citizens and naturalized citizens. Both are entitled to exactly the same rights and privileges. Both are expected to shoulder the same obligations and responsibilities. No one asks a citizen whether he is native born or naturalized. He's an American citizen, and that's that! Another case which comes to mind, unfortunately still not expunged from American life completely, is the regrettable holdover from the unspeakably horrid days of Puritanism, when the innocent and blameless offspring of unmarried parents were stigmatized with the label of illegitimacy. Though they were not different in any way from others, they were regarded as inferiors, and because of this barbaric practice, were denied status in society in an unbelievably broad spectrum of areas . . .jobs, education, social acceptance, marriage, civil service, freedom from the mischievous, wagging tongues of the vicious hypocrites who enjoy making others miserable at every opportunity.

Let us grant that the mail exams have been on the up and up . . .that not a single Conditional was party to any hanky-panky. Despite this concession, there will always be those who will wink, place their fingers alongside of their noses and nod knowingly. So long as someone wears that designation on his sleeve he is fated to be suspected of having cheated. Since we have just finished granting that such is not the case, and since all the Conditionals have applauded my eminent fairness with enthusiasm, the next logical step would be to require some of them (just a few . . .75%, for example) to prove that our utter confidence in their integrity was well merited. Boy, I can hear the gnashing of teeth and the blue vitriol ascending into the air right now, really I can.

Why in the name of Tophet cannot some machinery be devised for the purpose of *taking the exam to the applicant* who cannot come in under his own steam. If a single volunteer examiner is regarded as untrustworthy, why not employ the services of (if you will forgive a Russian term) a 'troika' . . .three people are hardly likely to risk any joint dishonesty for fear of subsequent disclosure. They could undertake to administer the test to the truly handicapped person who cannot possibly get to the examining point. And the exam should be given the same weight as the regular FCC exam, with all credits applicable for higher grades. This should be limited to absolute establishment of the candidates' inability to get to the FCC office. All others should be required to meet the standards that have been established for the upper three license grades. If necessary, as seems likely, some of the additional revenues now being reaped from the increases in renewal fees (up 125%) could be applied to the establishment of additional exam centers, and could be used to help defray the salaries of additional personnel. Then, when the test is taken, either by the troika method or the FCC method, let the applicant be issued a General class license, completely indistinguishable from others, destigmatized and totally immune to the jibes and insults of any "first-class" amateurs who might feel an inclination to accuse them of skullduggery.

The fact is that we cannot, in good conscience, permit a large number of operators, comprising literally thousands of individuals, to continue to enjoy a privilege which is *earned* by the vast majority, simply by feigning physical disabilities which, in far too many instances, exist only in their wishful imaginations. We cannot continue to tolerate equality of participation by those who waltz blithely through the mile-wide loopholes of the law, which conveniently allow them to take the ticket while ignoring the basic technical requirements. No matter how sorely handicapped an individual might be, he should at least be required to conform to a standard within the limits of his own ability and competence. To offer him a completely free pass, an Annie Oakley, is not only derogatory to the rest of us . . .it is an insult to the integrity of every single Conditional with a legitimate reason for holding that grade . . .and there are many, many of them.

I am sure that we all know sightless hams, amputees, victims of dread disease, shut-ins . . .who have spurned the Conditional license, and who have insisted upon being examined in the standard fashion, just like everyone else, in order to avoid being deemed cripples or invalids. We are all mighty proud of them, for they are a source of inspiration, and their achievements set an example of courage for all of us. Within the framework of that type of pluck and determination, how can we possibly dare to countenance the flimsy alibis and "plea-copping" of the indolent, unindustrious, shallow cheats who masquerade behind the technicalities of legalistic gobbledegook, even though it may be within the definable semantic terms of the FCC regulations?

Isn't it time some changes were made?

* * *

I never saw the beat of it; when you write comment, many people take it as a personal point of privilege to challenge you on everything . . .opinion as well as fact. It is as though an editorialist had no right to express his own ideas . . .that somehow when he allows his name to appear on the printed page, he must express only that which coincides with what *they* think . . .all other ideas become invalid!

Really, you have no idea of the tone of reproof, sometimes downright abusive, which

even one's best friends are likely to use in disagreeing with this or that editorial point of view on any given subject. Take the recent growth of lists on the DX bands, for example. This has now become the chief target for the rugged individualist types who keep insisting that they prefer pileups.

I have no axe to grind either way. I have such a minuscule number of DX credits, that I'm happy to take 'em any way I can get 'em. So my views are not subjective . . .not based upon my own needs . . .therefore unprejudiced.

While it is perfectly true that a well operated station using standard power, a medium height tower and an ordinary tri-band antenna, is adequate in the average hurly-burly of a minor or medium-size pileup, it is decidedly at a disadvantage in the prodigious traffic jam which inevitably occurs whenever a rare one turns up. The recent operations at ZA, AC3, KP6, ZK1, and Gus Browning's Indian Ocean activities all demonstrated the folly of attempting to compete on an equal basis with the super-kilowatt boys with the sophisticated antenna systems. Those boys stick out like a sore thumb . . .many "dB" stronger than the other hundreds of poor shnooks calling in the pileup.

In such cases, the list method tends to favor the less powerful stations, enabling them to make QSOs which they would have very little hope of getting under normal circumstances. Of course, this displeases some of the big noises, who evidently feel that they do not wish to lower themselves by soliciting anyone's aid for the demeaning purpose of standing in line to make a contact . . .any contact. They seem to think that they should not be required to wait in line, but should be accorded instantaneous and undivided attention by whomever they call. They are perfectly willing to have everyone else stand in a long queue, twiddling the thumbs, just so long as it is not they who are made to wait. And whenever these certain parties hear a list operation in progress, a couple of them invariably try to break right in and call right on top of everybody, simply because they are just not about to get used to waiting their turn. When they are asked to move off because the DX is working to a list, they commence lecturing all and sundry on the evils of lists, and how this is likely to destroy amatuer radio. Or, they move off about two kilohertz and QRM the frequency with all of their side hash.

If ever there was a sterling reason for me to feel kindly disposed toward the lists, this would be it. I think that it is high time that some of these super-mouths on the bands were made to feel a little less secure about their positions on invincibility. It's time somebody gave them a comeuppance.

Well, anyway, to get back to the lists . . .I decided that maybe I would support a couple of them, not just to get in on the DX, but because I happen to be a strong advocate of their sponsorship of DX stations by distributing gear to them. So, I sent in a few bucks . . .not a large amount at all, and I had the unmitigated temerity to announce the fact on the air to a few fellows I know. Boy! That's when the eggs hit the fan! They wouldn't even control themselves to the extent of waiting their turn to tell me off. They said I was stupid, shortsighted, foolish, naive, ignorant, radical, vicious, treasonable, and that I was losing my marbles. They doubled, tripled, and quadrupled, drowning each other out in a cacaphony of indignant outrage.

Well, if there's one thing I've learned since beginning this column, it is this: Whenever you get an angry reaction as a result of something you've written, you can be pretty sure you're on the right track! Nothing gets people who have enjoyed an advantage (particularly an unfair advantage) more upset and riled than a movement toward equalizing the situation.

Of course, even if the edge could be taken away, they would somehow find a way to regain it. I know a couple of guys who would do it legally, by developing more efficiency in the antenna system, and that's fine with me. But the answer for many of them . . .far too many . . .would be an illegal increase in power. Don't ever get the idea that the so-called California kilowatt is confined to the Golden State. The overpowered stations are all over the map, and what's more, everyone knows it. And as long as there are people who are willing to sidestep the regulations by running illegal power, then I am solidly in favor of list-taking, because it is just about the best way yet devised for overcoming the overwhelming odds which have been unfairly lengthened by these cheats and chiselers.

MAGNETIC CAR SIGNS

W2NSD/1

$4.00 postpaid!

Put this magnetic call sign on your car when you are on a trip and meet the hams along the way. Comes right off when the XYL drives the car, if she doesn't want to be bothered by hams tooting at her.

Send $4 along with your call letters today. Radio Bookshop, Peterborough, N.H. 03458. (USA only please).

TWO-TERMINAL CURRENT LIMITER

Gerald Beene
Greenville TX 75401

Many power supplies will not survive a short circuit. The reason for this is that in the low voltage supplies used for

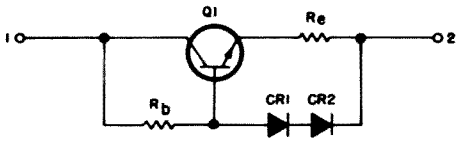


Fig. 1. Series current limiter circuit.

transistor circuit work, a series transistor is used to regulate the output voltage. If an unusually large current is demanded from the supply, and there is no current limiting,

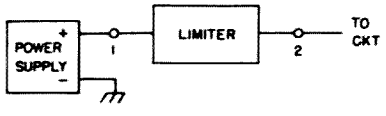


Fig. 2. Block diagram of limiter in typical application.

the peak current rating of the regulating transistor may be exceeded.

Other than the sensitivity of some power supplies to overload, experimental circuits are also subject to damage if for some reason excess current is allowed to flow.

A fuse alone will not necessarily provide the needed protection for current sensitive semiconductors.

The simple two-terminal current limiter shown in Fig. 1 will give instantaneous limiting for those slips of the probe, sudden shorts, etc. The use of a fuse in series with the limiter will reduce the need for a heat-sink on the transistor Q1.

The limiter is placed in series with the line so the current is from collector to emitter. Though shown polarized in Fig. 2, the limiter may be used with either polarity supply.

In order to design for a particular maximum current, select R_e such that

$$R_e = \frac{.6V}{I(\text{amps})}$$

and make R_b about ten times as large as R_e. CR1 and CR2 are silicon diodes such as 1N4002, 1N645, 1N2070, or just about any diode capable of at least 100 mA. Q1 is a silicon transistor capable of the current to which the limiter is designed.

It works like this. R_b is small enough to keep Q1 saturated as long as CR1 and CR2 are not conducting. As soon as the voltages drop on R_e reaches 0.6V, CR1 and CR2 conduct and regulate the output current by regulating the base voltage on Q1.

Gerald Beene ■

73 ARTICLE DIRECTORY 1970

This master article directory lists, by subject, all the major articles featured in 73 Magazine during 1970. Entries are first by subject (alphabetically), then by article title (chronologically). A brief abstract of each article appears once, though the article itself might be listed under more than one category. When no abstract appears and a subject heading is shown in parentheses between the author's call and the date of publication, refer to the parenthesized subject heading to read the abstract.

Antennas

AAB—AM—FM Modulation System

W2BSP Jan

Tongue-in-cheek technical article about a system the author actually uses. He calls it "frequency aperture" modulation. The most interesting part of the article is the author's clever adaptation of a 55 gallon drum for use as a 10 meter cavity.

Base-Tuned Center-Loaded Antenna

W2EEY Jan

An antenna *can* be center-loaded without having the reactive element physically present at the center of the antenna. Transmission line transfer of the reactive element is the key.

Variable-Impedance Mobile Mount

W1EMV Feb

A rotary switch with a few capacitors can effectively change the matching impedance of a mobile antenna.

Quick-Stop and Reverse Antenna Rotator Circuit

PY2AUC Feb

A simple rotor modification to make the antenna stop when you want it to. Also lets you suddenly reverse the antenna's travel without fearing damage to anything too high to reach comfortably.

The Glop Will Get You if You Don't Watch Out!

W2OLU Feb

The effects of glop (dirt and crud) on antenna connections. Contains suggestions for minimizing the likelihood of Glop build-up.

18-in. Dipole for 15 Meters

K9LGH Feb

Supersmall antenna for cliffdwellers; incorporates two printed-circuit radiating elements.

Lossy Transmission Lines

KH6IJ Feb

A description of the effects of an antenna transmission line's losses, and a discussion as to the insignificance of swr measurements under conditions of a lossy line.

How to Megger Your Antenna

W2EEY Apr

A simple, proved method for periodically checking performance of a transmission line and antenna system. Can uncover faults not indicated by swr measurements.

7/8-Wave Mobile Antenna for 2 meter FM

W2EUP Apr

An expert describes an antenna of original design, and compares it objectively with other antennas of commercial manufacture. In the Buffalo area, this 7/8-wave antenna has held the FM mobile gain record since 1967.

5/8 Wavelength Verticals

WA0NGV May

Theory and information on 5/8-wave verticals of various descriptions. Includes radiation-angle data, construction information, and necessary equations for original design.

The Little Wonder: Mark II

W5ZBC Jun

Another cliffdweller antenna. This one can be fashioned from an old pole lamp.

The 663 Beam

ZL2ASJ Jun

Six elements on 10 and 15, and 3 elements on 20m. Construction plans were left out, but were printed in the Aug issue (p. 83).

Quarter-Wave Top-Loaded Mobile Antenna

W5AZE Jun

An efficient, short quarter-wavelength dipole antenna for 20 meters.

Eleven-Element 2 meter Circular Quad

W4KAE Jun

A new type of antenna that seems to have a lot to offer.

The Sly Beam

ZL4TAH Jun

21 dB gain on 2 meters with a new approach to the construction of yagis.

Measuring the Difference Between Incident And Reflected Power

VE7BS Jun

The difference is the difference. Includes circuit for measuring reflected and forward rf.

The Effects of Temperature and Frequency On Coaxial Cable Loss

W9KXJ Jun

As transmission line temperature increases, so does loss — and vice versa. Complicating matters, the losses get worse as the operating frequency is raised. Includes charts.

Improving the Performance of Trap-Type Vertical Antennas

W2EEY Jun

The addition of another element can considerably improve the performance of multiband verticals. The added element can be automatically bandswitched and a transmission line system used which allows simple changeover from an omnidirectional to a directive radiation pattern.

A Practical DDRR Antenna

W6WYQ Jun

Ring-type low-profile radiator that is hard to build. Good for mobile rooftops.

Two Receivers from One Antenna

WA6UFW Jun

An easy-to-make signal splitter that allows maximum utilization and minimum loss.

Remote SWR Indicator

W2EEY Jun

Concentionally placed swr meters often do not indicate the true swr at the junction of the transmission line and antenna. Remote location of the reflected-power sensing portion of an swr unit is the key to true swr value indication.

The Low-Noise Antenna

WB6JNI Jun

Blasting the theory that an antenna always works as well receiving as it does transmitting.

Measuring RF Output

WA6CPP Jun

Using a cheapie meter to measure wattage.

Raising a Rhombic

W8DYF Aug

All you really need is space.

Log Periodic Antenna Designs for VHF/UHF

W3DUQ Aug

Three arrays are featured: 21—55 MHz, 50—150 MHz, and 150—450 MHz.

ATV: Getting a Better Picture

WA6BJV Aug

Plans for a good antenna and suggestions for other station improvements.

Brew 1 on 2 — a 2 Meter Coaxial Antenna

WA0RWQ Sep

The title is alluding to California's "Brew 102" beer. The article describes a beer-can coaxial antenna that can be fun to make if you obtain the cans as the author suggests.

Four-Wire Inverted Vee

WA6COB Oct

Simple but effective antenna for 40 and 80 meters.

Remote Quad Tuning

W6AJZ Nov

How to tune a quad stub from a control box situated at the operating console.

CW

The Combo

K4FQU Jan

A CW monitor that is installed between the key and the transmitter. Contains but one transistor. Simple. Effective.

Mobile CW

K6RA Jan

A fantastically great way to get yourself killed on a Los Angeles Freeway.

First Class Keyer Key

W6BLZ Jan

Quickie article describes a cute modification to modernize an inexpensive but readily available "bug."

A CW Monitor

WB2GQY Mar

How to get a 98¢ oscillator module to key on and off with rf. Uses a voltage doubler rf pickup.

Turning the AN/GRC-9 Into A Novice Rig

W6JTT Mar

A simple conversion puts this surplus unit on 80 and 40 meters. Converted, the rig will run about 15W. Includes a detailed power supply circuit. Modulatorless, the transmitter is intended for CW operation.

What Will Become of CW?

W5TOM May

A dissertation on the state of ham radio today, and suggestions for possible improvement. Makes a case — of sorts — for CW, and offers predictions for CW's role in amateur radio's future.

A Mobile CW Transmitter

W6BLZ May

For those who don't know what to do with their free hands while driving.

CW Can Be Fun

Staff Jun

An evaluation of Ord's DK-1 keyer.

QRP

WA3JBN Jun

Two simple rigs for CW operation on 40 meters.

How to Build a Keyer and Retain Your Status as an Appliance Operator

W9KXJ Jul

A couple of guitar picks and some relay contacts can turn out a pretty nice looking sending key.

Mobile CW Receiver

W6BLZ Jul

For people who just can't seem to get enough code during the evening at home.

The ICmitter

Goldstein Aug

Costs little and doesn't run much power, but it will put out a signal — AM or CW — on 40 through 160 meters.

Integrated Circuit CW ID Generator

W7PUG Sep

A device for automatic identification — with CW — of FM repeaters. Author also offers to supply PC boards plus computer printout of any call letters, as optimized with the author's computer.

Low-Cost Automatic Keyer: A First Project

WB4MYL Nov

Schematic, description, and circuit board layouts for an inexpensive keyer that can send from 10 wpm to over 30.

DX

How to Visit Foreign Countries

W2NSD/1 Feb

A few salient hints for prospective travelers and sometimes DX'ers.

Ham Exchange

WA2ELA Mar

First-hand report of a "ham exchange" whereby DX visitors stay with U.S. amateurs, then reciprocate later when the U.S. hams visit the DX country.

QSLing: Ham Radio's Own Con Game

VK4SS Jul

One ham's negative opinion of the state of DXing today.

Latham Island DXpedition

5H3LV Jul

Problems and successes in a recent DX trip to Zanzibar.

Worldwide ITU Prefix/Call Area List

W1SWX Jul

Reprinted from DX'er Magazine.

YO — An Interesting DX

YO2BO Oct

A look at Romania and a description of the hams and country.

FM

VHF—FM: A New Involvement

K6MVH Jan

The story of FM Magazine's demise and the promise of 73 to give adequate attention to FM, an area all but neglected by ham journals in the past.

Low-Cost Electronics: Japan's FM Invasion

K6MVH Jan

A brief overview of some of the 2m FM transceivers that are being inported for sale to the booming VHF ham market.

Setting Up the Tone-Burst System

W6TEE Feb

The little details that are necessary in setting up a toned repeater, including a tone-burst timer for the user mobiles.

Tone Decoder for Remote Switching Applications

K6MVH Feb

A simple and tested tone decoder that may be used for such repeater control applications as whistle-on and tone-burst access systems.

Encoders for Subaudible, Tone-Burst or Whistle-On Use

W6CZL Feb

An extremely simple and stable transistor oscillator circuit, with adaptations for the various modes of repeater control. Includes PC board layout and construction plans.

Frequency Synthesis: The Modern Way to Control Frequency

W2EUP Feb

A complete and comprehensive article covering theory and techniques of indirect frequency synthesis, plus schematics and a description of a practical 400-channel synthesizer used in a 2 meter FM transceiver, with only one frequency-determining crystal.

VHF—FM and You

K9STH Mar

A "what's-it-all-about" type article covering everything that's happening in FM right now.

6-to-12-volt Filament Conversion for the 41V

W6YAN Mar

Changing the cheaper 6V Motorola FM units to 12V types.

AC Power Supply Conversion for the Motorola 41V

K9PKQ Mar

Schematic diagram and helpful hints for converting Motorola's trunk-mounting mobile unit to a base station.

Remote Multifrequency Oscillator for Surplus FM Units

W2AUM Mar

Complete plans, PC layouts, and construction info for a four-frequency oscillator deck that can be used in the control head of such trunk-mounted units as GE, Motorola, Link.

Converting the Sonobuoy to a 2W FM Transmitter

W1BYX Mar

Schematic diagram, photo, and instructions for converting the AN/SSQ-23A underwater transmitter to a 2W 2 meter FM rig. Also tells where to get such transmitters.

Kris Scanning Receiver

Staff Mar

A close look at one of the newest entrants into the ham radio field.

A Look at Amateur FM Standards

WB6DJT Mar

A general survey of the VHF revolution with respect to repeaters over the past few years and some suggestions for planning ahead.

A Poor Man's Frequency Meter

W6YAN Mar

How to turn a cheap LM frequencu meter into an extremely accurate piece of test equipment. You'll need the front end from a Sensicon receiver, too.

The Fine Points of FM Operation

WB2AEB Apr

Good common sense for FM beginners. Includes good hints on setting deviation level.

Examining FM Repeater Operation

WB6DJT Apr

A state-of-the-art article telling it like it is, with suggestions as to how it ought to be.

A Repeater Controller

WA4YND Apr

The myriads of mechanical contrivances that repeaters inevitably wind up with can be replaced with transistor equivalents. . .with a resulting increase in system reliability and decreases in headaches for the repairman. Complete circuits, with timers, COR, keyer control, etc.

Understanding the Carrier-Operated Repeater

K6MVH Apr

The complicated repeater is not really so complex after all. . .it's only a matter of understanding the simple operations that are taking place when somebody transmits on the input frequency.

Evaluation: Standard 2m FM Transceiver

W6QGN Apr

A close look at the SR-C-806M transistor transceiver.

Directory of American Open Repeaters

Staff Apr

A comprehensive listing of open repeaters in the United States and Canada. Includes editorial introduction and writeup about repeaters in general.

FM Repeaters Under Fire From FCC

Staff Apr

The first published notice of FCC's infamous Docket 18803. Sketchy but essentially accurate.

A Word About Repeaters
WB2AEB — Apr
The trend for the future seems to be to use a compatible deviation of both narrowband and wideband rigs: this is accomplished with a peak deviation of about 8 kHz at the repeater transmitter. Other trends and characteristics also noted. Included with the repeater directory.

7/8-Wave Mobile Antenna for 2 meter FM
W2EUP — Apr
(Antennas)

FM—AM Transmitter-Receiver Aligner
W3JKL — May
A signal generator that can be used in conjunction with a transmitter to give a zero beat for frequency measurements. Also useful for aligning FM receivers.

The Intelligent Use of 2 Meters FM
K1ZJH — May
A general description of the way it's done on FM (it IS different), and a few words of wisdom to people who aren't used to working through repeaters.

A Low-Band Police Monitor
W6JTT — May
How to modify Motorola's old, no longer used 30D type receivers by building up a simple supply and diddling with the receiver oscillator.

The Wichita Autopatch
W@DKU — May
Tied in with the local repeater, this phone patch received approval from Ma Bell. Includes descriptions of the patch and tells how Ma Bell was conned into going along with the idea.

An FM Best Buy
WA7EMM — May
How to convert the world's rarest FM rig (Comco) from commercial service to the ham band.

FET Preamps for VHF FM
WA4WDK — May
Two good preamps are described — one for 6 and the other for 2 meters. Complete performance curves, construction data, schematics, etc. are given. Preamps are grounded-gate, which offers high gain, ease of tuning, and simplicity of construction.

Allied Portable FM Receiver
K9STH — Jul
An evaluation of Allied's A-2587 pocket FM receiver.

A Two-Channel Search-Lock for FM Receivers
W3DTN — Jul
Simple gadget turns a 2-channel rig into an automatic scanner type, and provides the added capability of locking onto a channel where activity is sensed.

Super Autopatch
K6MVH — Jul
Why automatic phone patches are important for public service. Includes construction data for a patch that does everything.

Repeater Audio: Time Out for Quality
K6MVH — Aug
Use of a cathode follower to pick audio directly from the repeater's discriminator can do wonders for an ailing amateur relay system.

Optimizing Antenna Separation in FM Repeaters
K6MVH — Sep
If the receiving range of your repeater can't match the output capability, the problem could be desensitization. And chances are you can solve the problem by as simple a step as moving the antennas around a little at the repeater site.

DyComm's 15W 2 Meter Mini-Amplifier
Staff — Sep
An evaluation of a ready-made 15W class C amplifier that can be used for VHF CW or FM applications, requiring only 20 mW of drive.

Integrated Circuit CW ID Generator
W7PUG — Sep
(CW)

Low-Cost Oscillator & Infinite Attenuator for Tuning VHF Receivers
K1CLL — Sep
A signal generator with a very reliable and repeatable attenuation device for adjusting receiver front ends to maximize sensitivity.

Controlling Repeaters with Tones
K6MVH — Oct
Basic repeater control logic, and how to set up a tone control system for tone-burst or whistle-on use.

Semiautomatic FM Channel Scanning
WA@QPM — Nov
Using ordinary flasher module, this unit connects to a two-channel FM transceiver to allow monitoring of both channels by a scanning sequence. Does not lock onto a signal.

2-Meter Minitransmitter for Repeater Use
WB6BIH — Dec
A straightforward, simple transmitter with five stages using five transistors.

Regency — an FM Late-Starter
Staff — Dec
A comprehensive comparison of the Regency 2 meter transceiver with other units currently available.

General Info

Fascinating Fundamentals: Volta and His Pile
W2FEZ — Jan
The interesting story of Volta and his experiments in galvanic research. Describes an early (and easily duplicated) battery.

Fascinating Fundamentals: The Terrible Jar at Leyden
W2FEZ — Feb
Interesting historical facts about the Leyden Jar; how to duplicate it and make your own capacitor.

How Do Ham Radio Stores Decide Trade-In Prices?
W2CEP — Apr
The owner of Stellar Industries gave this rundown on the way prices are figured in the amateur radio game. Stellar is no longer in the ham business, but the article is nonetheless applicable.

Beryllia — The Lethal Refractory
WB2PAP — Apr
Take another look at those tube boxes on your shelf; those ceramic jobs that are made with beryllia could be dynamite!!

Inexpensive New Semiconductors for the Ham
WA7KRE — Apr
Descriptions and representative circuits for a whole flock of recently introduced semiconductors from Motorola. Includes dual-gate MOSFETs, several power amplifiers, thyristors, rectifiers, etc. Circuits included: VHF amplifier, audio amplifiers, telephone amplifier.

London's Science Museum Demonstration Station
Ellison — May
A look inside the museum and a description of the amateur radio facilities there. Includes photos.

Plus Ten dB. . . .
W2OLU — May
A quick way to relate power to decibels, and an easy method for calculating one commodity or the other when one of the commodities is known.

Selectivity Has Come a Long Way
Swan — May
The theory of bandpass fillers and a description of Swan's newest entry. Includes performance specs.

Science Fairs: Science Education?
Mocking — May
A revealing look at the schools' approach to science education these days. Good reading for those who care.

Bigger Knobs for Better Performance
WB21CV — May
An encapsulated rundown on the findings of a high-cost program to human-engineer consoles. Modern science now says tiny knobs can cramp your style!

Epoxies for Electronics
W9KXJ — May
How to steal a trick from the professionals and use modern epoxies to perform the bonding that once had to be done with a hot soldering iron.

Comments on FCC Repeater Proposal
Staff — May
A point-by-point reprint of the FCC's Docket 18803, along with suggested revisions to make the rules more realistic and easier to live with.

Ground Support for the Powder Puff Derby
W7ZC — Jun
The ins and outs of providing communications for the most famous air contest in the world.

The Low-Noise Antenna
WB6JNI — Jun
(Antennas)

The Effects of Temperature and Frequency on Coaxial Cable Loss
W9KXJ — Jun
(Antennas)

Government Surplus Straight From the Horse's Mouth
WA9ANW — Jun
How to get on the Government's surplus gravy train. How to buy; how to bid.

Improving the Performance of Trap-Type Vertical Antennas
W2EEY — Jun
The addition o (Antennas) in consider-

The Club for Blind Amateurs
Champagne — Aug
Pictorial story of K1TPX, the Perkins Radio Club for the Blind.

Ham Radio Chess
W1EMV/@BMW W — Aug
Two schemes for annotating chess games for over-the-air play.

What Really Happened to Hamdom?
W9HBF — Sep
The author asks why we are in the state we are. He advocates QRO and a good beam as opposed to brute force power, and points to some uncomfortable comparisons between ham radio and citizens band.

YO — An Interesting DX
YO2BO — Oct
(DX)

AC Switching with Self-Powered ICs
W2FBW — Nov
A new approach to power switching of ac circuits: rfi is eliminated, power supply diodes are protected, switch contact wear is reduced, and tube heater life extended. ICs switch at the zero current point.

Pioneer Radio on the Prairie
W6CXC — Nov
Sentimental remembrances of E. E. Krebsbach and the contributions he gave to the field of amateur radio.

Helpful Hints

Proper Use of Silicon Diodes
1WA3ACL — Jan
How to use the ratings of diodes in your rectifier projects. Includes suggested applications for such diodes.

Simple Compact 6m Bandpass Filter
WA5SWD — Jan
A high-performance TVI for 6 meters that costs less than $5 to build. The filter is to be installed in the transmitter's transmission line.

Using Diodes for Adapting AC Relays to DC
WA5SWD — Jan
Simple shorty article showing the right way to use diodes for low-voltage rectification where the object is to use dc relays with an ac supply.

The DX-35 Revisited
W2AOO — Feb
A trick or two for updating Heathkit's popular DX-35 Novice rig.

From Breadboard to Printed Circuits the Easy Way
K1AOB — Feb
A simple system for making PCs by using an Xacto knife to cur around original artwork.

ProfessionalP PCs From Roll-Your-Own Negatives
K6MVH — Mar
A means for creating high-quality printed circuits without the time-consuming and expensive darkroom processes.

Easy Diode Testing
K4JK — Mar
A clever means for nondestructively testing "bargain" diodes to learn their PIV.

Super Sizer
WA3AQS — Mar
Many little modifications that will cut the resale value of Heath's Sixer, but which will surely make the rig work better.

Renovating Surplus Meters
WA@ABI — Apr
A test or two, a dab of white paint, . . . and presto!

Keep 'Em Cool in KPO Cans
G3KPO — May
Construction data for building simple heatsinks for vacuum tubes. The idea is to extend tube life and reduce heat dissipation within the tube envelope.

Epoxies for Electronics
W9KXJ — May
(General Information)

Bigger Knobs for Better Performance
WB21CV — May
(General Information)

Educated Idiot Lights

Holford — May
How to modify the car's "idiot light" warning system by adapting a buzzer to complement it.

Coax Adapter — VHF to BNC

W9MEV — Jun
A "quickie" article shows how to combine fittings to get a professional looking adapter.

Useful Cable Clamps

WA6CPP — Jun
A brisk shorty telling how to use hose clamps to hold cables.

De-RF Your VTVM

WAØFFJ — Jun
A quick and easy way to clean it up.

Two Receivers from One Antenna

WA6UFW — Jun
(Antennas)

Measuring RF Output

WA6CPP — Jun
(Antennas)

Installing the Swan 250C Noise Silencer

WA6CPP — Jun
Pictorial story tells how to do it neatly.

A Soldering Gun Tip

WB6PKA — Jul
Using silver-plated wire for soldering.

Mount That Mobile Right

K4IPV — Aug
The right kind of mobile installation will result in bigger signals, better operator safety, and more fun in hamming on the road.

ATV: Getting a Better Picture

WA6BJV — Aug
(Antennas)

Converting 24V DC Relays to 115V AC

Douglas — Sep
Three circuits and a brief article on how to accomplish this task.

Reed Relays for UHF/VHF Coaxial Switching

W7CRY — Sep
How to use reed relays in place of the expensive coax relays and get better overall performance. Includes frequency loss and isolation curves.

Neater Cabling With Nylon Cord

WAØABI — Oct
Use of nylon and heat to make it neat.

Improving Regulation in High Voltage Supplies

K6BW — Oct
Shorting out the surge resistors with a delay circuit to improve performance of a high-voltage regulated power supply.

Calibrate that Calibrator

W2KPE — Nov
Using WWV to calibrate the receiver 100 kHz calibrator more accurately than it has ever been calibrated before.

Solid-State Delta-F Control for SSB Exciters

W4NVK — Dec
Vernier tuning eliminates dial backlash and other tuning anomalies, and gives precision variable-frequency control of operating slot.

Two-Terminal Current Limiter

Beene — Dec
Simple series circuit holds current to safe level.

Humor

The Manuscript Game

Staff — Jan
Every good article gets its due reward.

How I Read the Radio Operator's Handbook and Found Happiness . . .

Johnson — Mar
The author's story of how he mastered ham radio theory overnight.

Bob-Bob-Bobbin' Along

K1YSD — Mar
Utter chaos and hilarious confusion from the pen of 73's only insane author.

That Contest Craze

VK4SS — Aug
An old tiger bares his fangs.

Code Practice a la Baby Talk

W9OXA — Sep
Sometimes there are advantages to becoming a ham that aren't even listed in the manuals.

Camouflage

K99AZG — Oct
How to buy lots of ham gear without letting the old lady know.

Clinks in a Vacuum

Derfler — Dec
A low-pressure article for wives. (Or for hubsands to show wives who don't dig radio.)

Hams are a Funny Bunch of People

K3KMO — Dec
A few of the paradoxes that make it easy for us to laugh at ourselves.

Yipes, It Talks!

W2FEZ — Dec
Fool your friends with a newspaper that talks. It's a homebrew electrostatic speaker fashioned from papers and foil.

IC Projects

Frequency Synthesis: The Modern Way to Control Frequency

W2EUP — Feb
(FM)

New Linear ICs for the Ham

WA4KRE — Feb
A down-to-earth description of Motorola's latest ICs doe amateurs, along with schematics lifted from Motorola's application notes. Includes power supply and regulator circuits, amplifiers, modulators.

A Logical Approach to Surplus Buying

K5JKX — Mar
How to identify and test ICs commonly found in the surplus market. Includes an extremely literate discussion of the principles of logic.

Low Frequency I-F Modules Using ICs

K1CLL — Mar/Apr
Description of what the author feels is the ideal i-f. This text includes a very good dissertation of the ins and outs of such popular i-fs as 455 kHz.

High-Performance Power Supply Using an IC Voltage Regulator

KØECF — Jul
0-20V at up to 500 mA in a tiny package.

An Impedance Multiplier for the VOM

K6DQB — Jan
Using an IC to do the trick.

The ICmitter

Goldstein — Aug
(CW

Three Versatile IV Testers

WA2IKL — Sep
This article lists pin diagrams for the common ICs and describes simple testers for checking digital, linear, and counter ICs.

Understanding and Using Integrated Circuits

W6DNS — Oct
All the basics; what they are, how they're used; why they're used.

The Phase-Locked Loop Comes of Age

K5JKX — Oct
A new IC and how it can be used in some pretty sophisticated circuitry.

Low-Cost Function Generator for Experimenters

WA2IKL — Oct
Makes sine, square, and sawtooth with excellent quality.

IC Marker Generator

K4BBC — Oct
Simple IC device gives marker signal when you approach the edge of your authorized band.

Practical IC Regulator Circuits for Hams

WB2EGZ — Oct
For a 500 mA supply.

ICs for Amateur Use

K1CLL — Oct
Describes a couple of good rf amplifiers using inexpensive ICs. One for 6 meters, another for 40.

AC Switching with Self-Powered ICs

W2FBW — Nov
(Gen. Info.)

Low-Cost Automatic Keyer: A First Project

WB4MYL — Nov
(CW)

Solid-State Transceiver for 40 Meters: the SST-I

W9ZTK — Nov
A modularized QRP rig with built-in swr bridge, CW monitor. Has ICs in audio and receiver sections.

Solid-Sate Exciter

W6YUY — Dec
ICs and transistors makes this SSB exciter modern, inexpensive, and efficient.

(HR PROJ)

Yipes, It Talks!

W2FEZ — Dec
(Humor)

Keyers

Transceiver Companion

W6AJZ — Jan
This is a complete control console and accessory for the transceiver that doesn't already have everything. It includes compressor, preamp, electronic keyer, phone patch, speaker, clock, and the kitchen sink all in one neat package.

CW Can Be Fun

Staff — Jun
(CW)

Low-Cost Automatic Keyer: A First Project

WB4MYL — Nov
(CW)

Mobile

Mobile CW

K6RA — Jan
(CW)

Base-Tuned Center-Loaded Antenna

W2EEY — Jan
(Antennas)

SSB-AM-FM Modulation System

W2BSP — Jan
Tongue-in-cheek technical article about a system the author actually uses. He calls it "frequency aperture" modulation. The most interesting part of the article is the author's clever adaptation of a 55 gallon drum for use as a 10 meter cavity.

The Camper — Mobile and Portable

WA9EHE — Feb
How to get the most out of a ham station when *you own a camper*, plenty of radios, and like to travel a lot.

Variable-Impedance Mobile Mount

W1EMV — Feb
(Antennas)

7/8-Wave Mobile Antenna for 2 meter FM

W2EUP — Apr
(Antennas)

RF Riviera Style

K9BDJ — May
The story of a Buick-owner's problems and how he traced them down in order to eliminate mobile interference.

A Mobile CW Transmitter

W6BLZ — May
f t
(CW)

An FM "Best Buy"

WA7EMM — May
(FM)

A Ham-Style Burglar Alarm for the Car

K2JLD — May
Description of a scheme for foiling prospective rig thieves.

Educated Idiot Lights

Hplford — May
(Helpful Hints)

5/8 Wavelength Verticals

EAØNGV — May
(Antennas)

The 27-Minute Mobile Limiter

W7SOH — May
How to build an effective noise limiter. As an alternative, the author shows how to modify an existing Bishop type noise limiter. The modification takes 27 minutes.

A Practical DDRR Antenna

W6WYQ — Jun
(Antennas)

Quarter-Wave Top-Loaded Mobile Antenna

W5AZE — Jun
(Antennas)

Installing the Swan 250C Noise Silencer

WA6CPP — Jun
(Helpful Hints)

Mount That Mobile Right

K4IPV — Aug
(Helpful Hints)

6V From 12 — The Easy Way

K3GSY — Sep
High current regulator that uses two transistor and a zener. Better approach than the "dropping resistor" idea.

Semiautomatic FM Channel Scanning

WAØQPM — Nov
(FM)

Noise Clippers

A Noise Blanker That Works

W8RHR — Apr
It DOES work, but the article somehow got into print without being edited, and there are some errors. Those who want to build should drop a card to editor of 73 to get straightened out on discrepancies.

The 27-minute Mobile Limiter

W7SOH — May
(Mobile)

Installing the Swan 250C Noise Silencer

WA6CPP — Jun
(Helpful Hints)

Novel Ham Radio Projects

Converting the 4CX1000 into a Lamp

K3QKO — Jan
A clever lamp for the ham's ham. Even has a switch fashioned from a coaxial connector. Better not to use a new tube for the lamp, though; it will have somewhat of an impact on the total cost of the project.

Transceiver Companion

W6AJZ — Jan
(Keyers)

The Dip Light

VE3ECU — Mar
A grid-dipper that uses lamp intensity instead of a meter.

Add Spotting to your VFO

K8BYO — Mar
Cute and simple technique that lets you hear the vfo without transmitting.

Reverse-Current Charging

K8YUC — Mar
With an almost foolishly simple technique you can successfully recharge ordinary dry cells, and make them hold the charge again and again.

Single-Sideband on the All-Wave Radio

W7CSD — Apr
A miniature tunable oscillator provides an ideal source for a beat-frequency signal, and allows you to hear code and SSB on any selective receiver without making modifications to your store-bought gear.

A Low-Band Police Monitor

W6JTT — May
(FM)

A Ham-Style Burglar Alarm for the Car
K2JLD — May
(Mobile)

Educated Idiot Lights
Holford / How — May
(Helpful Hints)

The *Consummate* Console
WB2FBF — Aug
Increasing station efficiency and enjoyment with a broadcast-style console. Include's plans and construction data.

IC Marker Generator
K4BBC — Oct
(IC Projects)

Solid-State 10-Minute Timer
WB4MYL — Oct
Plans, layout, and PC pattern for a MOSFET timer for various station functions or repeater applications.

Power Supplies

Simple Bench Power Supply
ZL2AMJ — Jan
Provides four output voltages, three current-overload limits. The techniques described can be applied to other power supplies.

Proper Use of Silicon Diodes
WA3ACL — Jan
How to use the ratings of diodes in your rectifier projects. Includes suggested applications for such diodes.

A 10m/CB Preamp
WA3HMW — Jan
Using a surplus 10m preamp with a slight amount of conversion. Details include power supply instructions.

Using Diodes for Adapting AC Relays to DC
WA5SWD — Jan
Simple shorty article showing the right way to use diodes for low-voltage rectification where the object is to use dc relays with an ac supply.

New Linear ICs for the Ham
WA4KRE — Feb
(IC Projects)

Turning the AN/GRC-9 Into a Novice Rig
W6JTT — Mar
(CW)

A Simple Bias Regulator for Linear Amplifiers
ZL2ANG — Apr
Shunt regulation for bias supplies offers the advantage of low constant current drain, and it can be used with the neglected — till now — class B and AB2 linears.

Vacuum-Tube Load Box
Ashe — Apr
Schematics, photos, and construction details for a power supply test set . . .

Power Supplies From Surplus Components
WB6BIH — May
Lots of theory and a few schematics for converting old surplus junk into something useful. If you're a mathematician, this is certainly your bag.

High-Performance Power Supply Using an IC Voltage Regulator
KOECF — Jul
(IC Projects)

More Notes on Diode Stacks
W2BDG — Sep
A description of GE's high-power (5 kV at 300 mA) rectifier modules.

6V From 12 — The Easy Way
K3GSY — Sep
(Mobile)

Simple Regulated *Power Source for* ICs
W1RAN — Oct
Regulated power supply using series diodes (not zeners) to give precise values of required voltages.

Practical IC Regulator Circuits for Hams
WB2EGZ — Oct
(IC Projects)

Improving Regulation in High Voltage Supplies
K6BW — Oct
(Helpful Hints)

Differential J-FET Preamplifier
W4KAE — Nov
Design, construction data, and performance curves for a low-noise preamp using an RCA CA-3028 J-FET. Includes separate power supply circuit.

Your Second Linear
W4AYI — Dec
High-power linear amplifier using a 3-500Z vacuum tube for the final. Includes schematic for a kilowatt power aupply.

QRP

"Quazar" QRP 40m DSB Transmitter
WA5WWN — Jan
Good low-power rig for sideband or CW; uses 4 transistors and an audio amplifier module.

Postage Stamp Transmitter for Six
K1CLL — May
Complete plans — including part list, layout, schematic, and construction details for a transmitter that is an eighth of an inch thick and only 3/4 in. square. This one really works, too.

QRP
WA3JBN — Jun
Two sample rigs for CW operation on 40 meters.

The ICmitter
Goldstein — Aug
(CW)

VHF AM Transmitter Using Low-Cost Transistors.
Brubaker — Aug
If it'll work on AM it'll work on FM.

ICs for Amateur Use
K1CLL — Oct
(IC Projects)

2W 6 Meter Transmitter Using the Heterodyne VFO
K1CLL — Nov
Breadboard design, tuneup, and performance of an rf power stage on 6m using a $3 transistor and a stable vfo circuit.

Solid-State Transceiver for 40 Meters: the SST-1
W9ZTK — Nov
(IC Projects)

2-Meter Mmitransmitter for Repeater Use
WB6BIH — Dec
(FM)

Receivers

Solid-State Double-Bandwidth Tunable I-F Converters
K1CLL — Jan
A good tunable converter can get you any frequency or band in the VHF range you want. This article tells how, and it includes schematics, parts lists, and complete instructions.

A 10m/CB Preamp
WA3HMW — Jan
Using a surplus 10m preamp with a slight amount of conversion. Details include power supply instructions.

A Simple IC Q-Multiplier
W2EEY — Feb
Using an IC opamp for a Q-multiplier. Advantages include simplicity, broad range of operation, and variable Q and peaking frequency.

High-Performance Converter for 6
WA9HES — Feb
Tube-type converter uses a Nuvistor. This article may become valuable as the last tube converter circuit ever published.

Low Frequency I-F Modules Using ICs
K1CLL — Mar/Apr
(IC Projects)

High Performance I-F Amplifier and AGC System
ZL2BDB — Apr
For CW or SSB work, you'll find this system hard to beat with its fast-attack, slow-decay characteristics. A wide latitude of stage gain is assured with both forward-and reverse-acting age elements.

Hot Carrier Diode Mixer Converter for 2 Meters
WA6NCT — Apr
Low noise, high gain, excellent overload resistance, and a very high degree of isolation combine to make the hot carrier diode particularly attractive for applications in receivers and converters. This article has good PC layouts, photos, schematics.

FET Preamps for VHF
WA4WDK — May
(FM)

I-F Filter, Converter, AVC "Ideal" Circuits
K1CLL — May
The second half of Hoisington's two-article series on the ideal i-f. This one includes breadboarding the complete I-f system.

450 MHz Mighty Mite
K9VXL — Jul
A superregenerative receiver for 432 MHz. Includes PC layout.

Mobile CW Receiver
W6BLZ — Jul
(CW)

Deluxe Receiver Gain Control
VU2JN — Sep
Improving age performance in tube-type receivers with the addition of a transistor control circuit. Includes chart showing tracking curve.

A Versatile and Stable MOSFET Converter for 144 MHz
WB6YVT — Sep
A low-noise, high performance converter with excellent gain.

The Phase-Locked Loop Comes of Age
K5JKZ — Oct
(IC Projects)

Differential J-FET Preamplifier
W4KAE — Nov
(Power Supplies)

RF Applications of the Dual-Gate MOSFET
Sir — Nov
Application suggestions from the engineering desk at Fairchild Semiconductors. Includes receiver circuits and amplifiers for VHF.

Repeaters

Setting Up the Tone-Burst System
W6TEE — Feb
(FM)

Tone Decoder for Remote Switching Applications
K6MVH — Feb
(FM)

Encoders for Subaudible, Tone-Burst or Whistle-On Use
W6ZCL — Feb
(FM)

A Look at Amateur FM Standards
WB6DJT — Mar
(FM)

A Work Session on the Wichita Repeater
WØDKU — Apr
Nobody knows any better than the repeater owner just how religiously Murphy's laws are followed by Nature . . .

FM Repeaters Under Fire From FCC
Staff — Apr
The first published notice of FCC's infamous Docket 18803. Sketchy but essentially accurate.

Examining FM Repeater Operation
WB6DJT — Apr
(FM)

Understanding the Carrier-Operated Repeater
K6MVH — Apr
(FM)

Directory of American Open Repeaters
Staff — Apr
(FM)

A Repeater Controller
WA4YND — Apr
(FM)

A Word About Repeaters
WB2AEB — Apr
(FM)

The Wichita Autopatch
WØDKU — May
(FM)

73 Comments on FCC Repeater Proposal
Staff — May
(General Information)

(General Information)

The Intelligent Use of 2 Meters FM
K1ZJH — May
(FM)

A Two-Channel Search-Lock for FM Receivers
W3DTN — Jul
(FM)

Super Autopatch
K6MVH — Jul
(FM)

Repeater Audio: Time Out for Quality
K6MVH — Aug
(FM)

Optimizing Antenna Separation in FM Repeaters
K6MVH — Sep
(FM)

Integrated Circuit CW ID Generator
W7PUG — Sep
(CW)

Controlling Repeaters with Tones
K6MVH — Oct
(FM)

Solid-State 10-Minute Timer
WB4MYL — Oct
(Novel HR Projects)

2-Meter Minitransmitter for Repeater Use
WB6BIH — Dec
(FM)

Reviews

Kris Scanning Receiver
Staff — Mar
(FM)

Evaluation: Standard 2m FM Transceiver
W6QGN — Apr
(FM)

The Grundig "Satellite" Receiver
Staff — Jun
An evaluation of a portable receive that has everything, including stable SSB.

CW Can Be Fun
Staff — Jun
(CW)

Allied Portable FM Receiver
K9STH — Jul
(FM)

The Knight-Kit RF Generator
W9KXJ — Aug
An evaluation of the KG-696 signal generator.

DyComm's 15W 2 Meter Mini-Amplifier
Staff — Sep
(CW)

Regency — an FM Late-Starter
Staff — Dec
(FM)

SSB

Single-Sideband on the All-Wave Radio
W7CSD — Apr
(Novel HR Projects)

A New Approach to Communications Equipment
K9ALD — Sep
The author describes a modular concept for standardizing of SSB transceiver design. The object is to improve performance of each module in an SSB system, while affording hams the opportunity of building or repairing their own.

Your Second Linear
W4AYI — Dec
(Power Supplies)

Solid-State Exciter
W6YUY — Dec
(IC Projects)

Solid-State Delta-F Control for SSB Exciters
W4NVK — Dec
(Helpful Hints)

Surplus

A 10m/CB Preamp
WA3HMW — Jan
(Power Supplies)

Using Diodes for Adapting AC Relays to DC
WA5SWD — Jan
(Power Supplies)

Facsimile and the Radio Amateur
K6GKX — Jan
More on adapting surplus equipment to ham FAX service; includes photos of equipment, block diagrams, and a chart showing transmission frequencies and times for various stations.

The Knight-Kit RF Generator
W9KXJ — Aug
(Product Reviews)

An Impedance Multiplier for the VOM
KDBQ — Jan
(IC Projects)

File Box Resistance Decade
WB4ITN — Sep
The first in a series of "file box" articles. Here the author makes a precision decade box and includes schematics for variations of his own design.

The Indicating Oscillator
KH6AF — Sep
A grid-dipper without grids. Uses FETs. Includes a circuit for amplifying microamps to milliamps, which should be handy for other projects as well. But be careful. Fig.1 is labeled 2 and vice versa.

Three Versatile IV Testers
WA2IKL — Sep
(IC Projects)

Low-Cost Oscillator & Infinite Attenuator for Tuning VHF Receivers
K1CLL — Sep
(FM)

A Low-Cost RF Wattmeter
WA3AJR — Nov
Inexpensive means of using an ordinary meter and a conversion chart to accurately gage power output from 4 to 4000 Watts.

Calibrate that Calibrator
W2KPE — Nov
(Helpful Hints)

The Transi-Test
WB6QQP — Dec
Useful but simple device can measure transistor beta, leakage, and shorts.

The Little Gate Dipper
W5ETT — Dec
Another grid-dipper with no grid; covers 1.7 to 225 MHz, yet is cheap and quick.

Turning the AN/GRC-9 Into a Novice Rig
W6JTT — Mar
(CW)

A Logical Approach to Surplus Buying
K5JKX — Mar
(IC Projects)

A Poor Man's Frequency Meter
W6YAN — Mar
(FM)

Converting the Sonobuoy to a 2W FM Transmitter
W1BYX — Mar
(FM)

An Inexpensive RF Wattmeter
WB4MYL — Mar
Simple adaptation of a piece of surplus equipment.

Power Supplies From Surplus Components
WB8BIH — May
(Power Supplies)

Government Surplus
Straight from the Horse's Mouth
WA9ANW — Jun
(General Information)

Converting 24V DC Relays to 115V AC
Douglas — Sep
(Helpful Hints)

Test Equipment

Test Equipment
Panoramic Receiver for VHF
I1SLO — Feb
A spectrum analyzer of sorts. Let's you see on a CRT the whole 2 meter band at once.

Frequency Synthesis:
The Modern Way to Control Frequency
W2EUP — Feb
(FM)

Extra Services from Your Grid Dip Oscillator
WA4UZM — Mar
A plug-in adapter turns a grid-dipper into a good crystal calibrator.

An Inexpensive RF Wattmeter
WB4MYL — Mar
(Surplus)

A Poor Man's Frequency Meter
W6YAN — Mar
(FM)

Vacuum-Tube Load Box
Asbe — Apr
(Power Supplies)

How to Megger Your Antenna
W2EEY — Apr
(Antennas)

FM-AM Transmitter-Receiver Aligner
W3JKL — May
(FM)

Measuring the Difference Between Incident and Reflected Power
VE7BS — Jun
(Antennas)

Remote SWR Indicator
W2EEY — Jun
(Antennas)

Measuring RF Output
WA6CPP — Jun
(Antennas)

Amateur Wattmeter for $3.85
K1CLL — Aug
Tells you your power output from about 10 mW to 5W, over the range from 160 meters through 450 MHz. Principle is based on comparison of an rf activated lamp with another of same brilliance whose power input is known.

Transmitters

"Quazar" QRP 40m DSB Transmitter
WA5WWN — Jan
(QRP)

Postage Stamp Transmitter for Six
K1CLL — May
(QRP)

VFO Circuit
KØHVK — Jun
Tube-type for 80 and 40 meters. Easy to build.

QRP
WA3JBN — Jun
(CW)

Cheapie 6-Meter Half Gallon
K1CLL — Jul
It works out to $12.50 a quart, and features low-cost tubes, no screen voltage, no bias requirements, and no blower.

The ICmitter
Goldstein — Aug
(CW)

VHF AM Transmitter Using Low-Cost Transistors.
Brubaker — Aug.
(QRP)

ICs for Amateur Use
K1CLL — Oct
(IC Projects)

Solid-State Transceiver for 40 Meters: the SST-1
W9ZTK — Nov
(IC Projects)

Solid-State Exciter
W6YUY — Dec
(IC Projects)

Your Second Linear
W4AYI — Dec
(Power Supplies)

TV

Slow-Scan Color TV
W4UMF — Jan
The principles of color separation, as applied to slow-scan television systems. Includes spectral charts, photos of off-the-air pix.

Bibliography of SSTV
W4UMF — Jul
Complete directory of articles.

Improved Color Transmission — SlowScan TV
W4UMF — Jul
Applying the principles of color separation and synthesis.

ATV: Getting a Better Picture
WA6BJV — Aug
(Antennas)

Amateur TV is Easy
K2OJL — Dec
It actually costs no more than $100 to get started in the fun hobby of amateur TV.

(UHF)

Amateur TV is Easy
K2OJL — Dec
(TV)

UHF

450MHz Mighty Mite
K9VXL — Jul
(Receivers)

Log Periodic Antenna Designs for VHF/UHF
W3DUQ — Aug
(Antennas)

ATV: Getting a Batter Picture
WA6BJV — Aug
(Antennas)

Reed Relays for UHF/VHF Coaxial Switching
W7CRY — Sep
(Helpful Hints)

VHF

Solid-State Double-Bandwidth Tunable I-F Converters
K1CLL — Jan
(Receivers)

Panoramic Receiver for VHF
I1SLO — Feb
(Test Equipment)

High-Performance Converter for 6
WA9HES — Feb
(Receivers)

Super-Sixer
WA3AQS — Mar
Many little modifications that will cut the resale value of Heath's Sixer, but which will surely make the rig work better.

Inexpensive New Semiconductors for the Ham
WA7KRE — Apr
(General Information)

7/8-Wave Mobile Antenna for 2 Meter FM
W2EUP — Apr
(Antennas)

Postage Stamp Transmitter for Six
K1CLL — May
(QRP)

The Sly Beam
ZL4TAH — Jun
(Antennas)

Eleven-Element 2 meter Circular Quad
W4KAE — Jun
(Antennas)

Cheapie 6-Meter Half Gallon
K1CLL — Jul
(Transmitters)

VHF AM Transmitter Using Low-Cost Transistors.
Brubaker — Aug
(QRP)

Log Periodic Antenna Design for VHF/UHF
W3DUQ — Aug
(Antennas)

Low-Cost Oscillator & Infinite Attenuator for Tuning VHF Receivers
K1CLL — Sep
(FM)

Brew 1 on 2 — a 2 Meter Coaxial Antenna
WAØRWQ — Sep
(Antennas)

DyComm's 15W 2 Meter Mini-Amplifier
Staff — Sep
(CW)

Differential J-FET Preamplifier
W4KAE — Nov
(Power Supplies)

2W 6 Meter Transmitter Using the Heterodyne VFO
K1CLL — Nov
(QRP)

Semiautomatic FM Channel Scanning
WAØQPM — Nov
(FM)

RF Applications of the Dual-Gate MOSFET
Sir — Nov
(Receivers)

20Meter Minitransmitter for Repeater Use
WB6BIH — Dec
(FM)

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IC Troubleshooting: A Matter of Temperature?

Many hours can be wasted troubleshooting IC equipment if you overlook one important characteristic. The popular Fairchild epoxy case ICs and the Motorola MC 700 series and HEP (dual in-line package) series are designed to operate between the temperature extremes of +59° F to +131° F (Fairchild) or +167° F (Motorola).

If your shack is in the garage like mine or at least unheated, you may very well be operating these ICs below their design temperature range during the winter months. Therefore, if your keyer, counter, or whatever seems to be operating erratically or not at all, take it into the house and give it six or more hours to attain room temperature. Then see if your trouble is still there. You may save yourself alot of time and frustration. (You may also have to buy a heater for your shack.)

Rich McMahon WA6IGU ■

LETTERS

advised by my lawyers that
ou goons don't ever proof'r
l asy
b nch
you ignored my comments in
I insist that you print ev
should be boiled in oil ov

Bottomless

I would like to take advantage of your most gracious money saving special 3-year subscription to 73. I still have a card you gave me at a Hamfest last year so I could get 3 years for $10, but I suppose it's too late to use it now. 73 is still the best ham magazine on the market, and I am tired of having to run down to the dirty book store on Broadway in San Francisco's "Topless-Bottomless" North Beach night club strip. You would be surprised, though, how many hams from all over I have met standing in that dirty book store reading 73.

So please accept my check for a 3-year subscription to 73, and come on out to California again when you can, and maybe you can stop in and meet some hams. They're always in the dirty book store reading 73.

Larry Johnson K7VZH
2051 Fremont Street
Klamath Falls OR 97601

Jordan

After attending the ARRL convention, and sitting in on several of your meetings, I felt that I should write you. First of all, may I honestly say that I found the most interesting part of the entire convention to be located in the 73 room on the 4th floor. In particular, I was fascinated with the slides of King Hussein and Jordan, and the slides of YO2BO, whom I talked with at YO2KAC in the late 1950x. As one of those who spoke with you when you operated JY1 in Jordan, I sent my QSL card to Box 1055 in Amman and received a beautiful QSL card personally signed by the king.

I then decided to write again and request an autographed photograph of His Majesty suitable for framing. In the letter I told the king that I was a Social Studies teacher and that I would surely appreciate an autographed photograph that I could not only use for educative purposes, but also could frame for display purposes in my radio room. I really never expected an answer from such a busy and important person. About a

New! MULTI-ANTENNA COUPLER

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- Change bands without having to switch antennas!
- Combine your antennas into a multi-band antenna system while retaining optimum antenna performance on each band!
- Coupler feeds any combination of antennas from a single transmission line! Saves operating time! Saves coax and switches!
- Coupler isolates the line from all antennas but the one in use!
- Works with all types of antennas! Handles full legal power!
- Models available for any bands, 2 to 160 meters! Weatherproof!

Shown above: Model 3, for 10/15/20 meters. Terminals: SO-239 $29.95 ppd.

antennalabs

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month later, however, the postman brought a large white envelope with ten stamps on it. On the back of the white envelope was a large gold crown.

Upon opening the letter I was amazed to find another QSL card signed by the king along with a personally autographed photograph dated July



25, 1970. Both the date and the signature were obviously in the king's own handwriting. I have framed the card, picture, and stamp section of the envelope and am enclosing a picture of it with this letter.

Vernon G. Dameron, Jr. K1DRN
265 Davis Road
Bedford MA 01730

You have no doubt kept up with the situation in Jordan in the last few weeks. According to the reports I have heard the situation is bad, especially in regards to medical help, food supplies, and so forth. Perhaps someone else has already made this suggestion but I was thinking it might be helpful if we hams banded together and all pooled our contributions for some help to the people in Jordan. I don't know who, if anyone, could organize such a program within the ham population but I would help if such a program is feasible.

The king was very friendly while you were there and it would be very generous on the part of the hams of the U. S. if we could help him in his time of need. I would appreciate your comments on this. Keep up the good work in 73. I am now a lifetime subscriber and am happy to be one.

Richard J. Malby GS9E
537-44-0619
579th Ordinance Co.
APO New York, N. Y. 09035

Camouflage

I just finished reading K9AZG's article CAMOUFLAGE, 73, October 1970, and I think I can help him out. He was in a similar position to mine, trying to get a 50 ft mast and tribander up without letting the XYL know. I solved the problem by covering the top section of the mast with brown paper, adding a few branches or so on it, and "planted" it. Every few months or so I added a section to the bottom to make it "grow." The tribander was painted green and covered with leaves. Next I "pruned" the lower branches off, leaving only the beam. The brown paper eventually falls of, and if the XYL is at all near-sighted, the system is almost foolproof.

Bill Ames WA0WBJ
1909 Karlin Dr.
St. Louis MO 63131

WAAS

Do you still issue the WAAS certificate? If so, will you please forward the necessary forms so that I may make application in the name of the club who sponsored and operated K6SB for the San Diego 200th bicentennial celebration. K6SD operated from October 1968 until October 1969 contacting as many hams as possible while celebrating San Diego's 200th birthday. During that year we were able to contact every state in the union, including Alaska and Hawaii, except Delaware.

So you can see K6SD does truly qualify for "Worked Almost All States."

Robert R. Smith WB6ODR
President El Cajon ARC

Yup, still available. Send 49 cards and $1.00 to cover costs of mailing, etc. . . . Wayne

FM Coverage

I am involved with two repeater groups here in the Denver area, and am in charge of a project to set up a new repeater for the Colorado Civil Air Patrol west of Denver, Colo. Thank you for the excellent coverage your magazine has given during 1970 to FM repeater activities and techniques.

Cliff Flaharty WA0 CKS
Box 1007
Littleton CO 80120

Inflation in a Nutshell

Popular opinion seems to be that the FCC fee hike is an inflationary move. Well let's get things straightened out. The fee hike happens to be a noninflationary move. By making amateurs pay more for their licenses this will take money out of circulation giving hams less to spend.

The whole thing that starts inflation rolling in the first place is the fact that people have too much money to spend. This action of spending puts more money into the hands of the business man. When he gets more money, his workers want more money. When the workers get more money this cuts down on the profit margin of the business man. Seeing that he is making less money the business man will raise prices to equal what he was making before. And the cycle goes on and on.

Joseph F. Lutz WB8EAS
2951 S. Moreland Blvd
Cleveland OH 44120

Delightful theory, but I don't believe it. I tend to agree with the economists who feel that historically inflation arrives on the heels of the night shift at the Treasury Department when they print more money than is being taken out of the economy in taxes.

. . . Wayne

CBers and Hams

What's going to happen to American Private Citizens' Radio? That's how I refer to all civilian radio communications, chiefly amateur radio and CB. Today we are in the strange and destructive position of having two separate and competing civilian radio services. Competing for members, prestige, and frequencies. How absurd! Under this set-up it's not only likely, but inevitable that conflicts will arise, and it's not too difficult to see who's been winning the last few years. I don't know how this unfortunate situation developed, completely.

I think Wayne Green came close to the solution a couple of months ago with the proposal of the Hobby Class license. This would move the CBers and their short range communications to 220 MHz, the least wanted ham band. Actually it was sort of a compromise, but the important point is: it would unite the two services into a single licensing and communication structure! I support this 100 per cent. But. There are problems. 875,000 CBers won't relish the thought of replacing their equipment, just so they can call themselves hams. Most people already think they are!!

Anyway, how about a conciliatory approach to CB? They're not dumb. Most are friendly and some are real sharp ops. If we can assimilate and unite the two radio services, not abruptly but as fast as possible, then we will be able to provide better total service, and we will have a much more powerful position in the national and international radio structure. It won't be easy, certainly; but it appears to be the only reasonable solution that would not interfere with the distinct but related services we provide.

Mark R. Hansen WA9YEC
1701 West Eighth Street
Marshfield WI 54449

Boo Boo

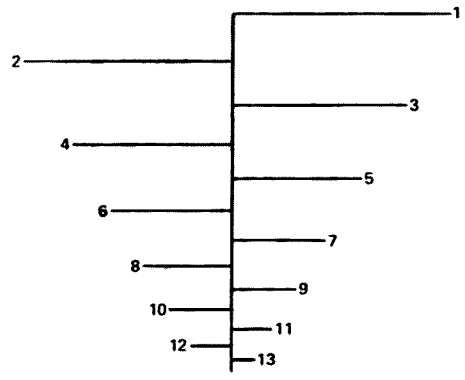
I have been receiving a tremendous amount of mail concerning two items in the August 1970 73 article on Log Periodics. Perhaps you could print a couple of items to straighten things out for your readers,

In middle columns of Table 1 (p.45), the third longest element length is 1.404 ft., not 1.304.

Also, perhaps you could redraw Fig. 1 with a top view of one boom assembly only. My questioners aren't sure of the element attachments which are not clear in the figure.

Try this idea:

TOP VIEW (one boom)



I hope you can find room to put this in 73 real soon to straighten people out.

Bill Nagle W3DUQ
RD 1 Box 188A
Honey Brook Pa 19344

Busted

My fictional story, "That Contest Craze," in August '70 issue of 73 (in which I am not too kind to a young cop who slaps on me a $5 parking fine) has prompted members of the police force here and abroad to write and say, "Why send us up...Don't we have enough trouble with the teenagers without an oldie like you getting on the wagon?"

Constable First Class Gerry Letford (VE3FTV) has added another $5 violation fine (No.110932) for illegally parking my Big Red Kangaroo car in his hometown of St. Catherine, Ontario – and if unpaid a warrant follows.

Another Constable ham mate in the north of my home State has invited me up for a few days. He guarantees to land me with something heavier than a parking fine.

In the local village here, the sergeant (who borrows my 73 mags) booked my son and said, "I'd prefer to give this ticket to your OM."



A HAMSHACK WITHOUT A GLOBE?
Ridiculous!

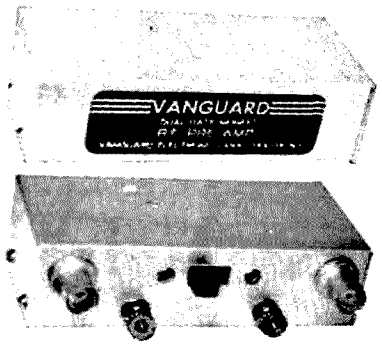
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13" inflatable globe (guaranteed, by the way), regularly selling for $15, now special, while they last, **ONLY $10.**

13" lighted globes, regularly $25, now **ONLY $15.** We have a few of these in stock and when they are gone, that is it.

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to 175 MHz. **$21.95** ppd.
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NEW FOR 1970!
The above models now have rf gain control.

For 300 to 470 MHz
See Model 202 in our catalog.

- Available from 5 MHz. to 450 MHz. Bandwidth is approximately 3% of frequency.
- Voltage gain 30 to 40 DB depending on frequency.
- Two Dual Gate MOSFET amplifier stages with each having a tuned input and tuned output. Each Dual Gate MOSFET is actually an integrated cascode circuit thus giving you 2 cascode circuits equivalent to 4 triodes.
- Exceptionally low noise (2.5 DB at 175MHz.), greatly reduced cross modulation and 10 times the dynamic range (signal handling capability) of the best bi-polar transistors. Also superior to preamps using junction FETs and Single Gate MOSFETs.
- Internal connections for high impedance AGC or manual gain control if needed.
- Type BNC input and output receptacles for minimum loss at UHF. Standard impedance is 50-75 ohms.
- Carefully tuned at our laboratory with sweep generator and oscilloscope for the best bandpass characteristic.
- Full wave UHF diodes protect input transistor.
- Operates on 6 to 16 volts DC, 5 to 15 Ma.

New York City and State residents add local sales tax.

VANGUARD LABS
Dept. H
196-23 Jamaica Ave., Hollis, NY 11423

I've already paid the $5 fine that pinheaded cop put on me in the story. If much more of this keeps up, the check for it will be busted. So please, fellers, lay off. I know when I'm beat. I'll go quietly.

Alan Shawsmith VK4SS
West End
Brisbane
Queensland
AUSTRALIA

Blunders, Blunders

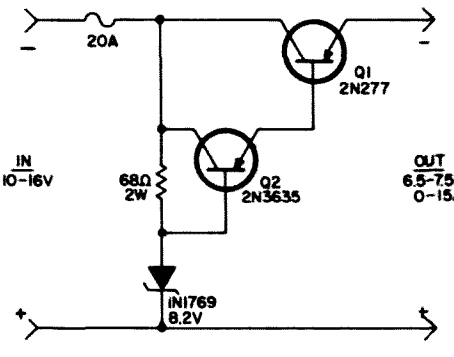
I still think your magazine is the greatest for the ham; have continued to think so ever since I subscribed very early in your magazine's career. Keep it up.

I want to be an old stinker and point out a couple of technical goofs in Sept 73. First, a little layout problem on page 30. Figures 1 and 2 are obviously interchanged. Otherwise, I have to suspect that it will work fine. I'll soon know; I am in the process of converting my old Heathkit grid dipper, since most of the key parts can be used.

Now, look at page 26 (same issue). That voltage dropper has something goofed up on it. The way it is drawn, Q1 will never conduct. Either Q1 and Q2 must be changed to corresponding NPN types or the input and output polarities must be switched (with a corresponding reversal of the zener diode). Otherwise, it seems to be a good scheme, within the limitations already mentioned by the author.

Harry K. Long, W7CQK
220 Seneca Ave NW
Renton, Washington 98055

You're right in both cases. Here's the correction for the p. 26 goof.



. . . Ken

Objectivity

This letter has a dual purpose. As long as I must write to you, I want to express my deep satisfaction with the policies of the mag. 73 mag has reached a height of editorial freedom I have not encountered even in Time or Newsweek. 73 allows each of its editorialists complete freedom while it has also opened its pages to critical comment and occasional discussion. Your heading to the "Letters" shows that you are interested in the irate and sometimes ignorant views as well as informed, intelligent ones.

Jim Altman WA0UWL/2
Box 6136, River Campus Sta.
Rochester NY

Politics, Religion and Sex

I have been an amateur for 8 years now and have become somewhat sick with the regular routine in which a QSO is supposed to be carried on. A few months ago I began to experiment on 40 meters in the way of trying to make a QSO more meaningful. I have been told by many people on the bands that politics, religion, and sex shouldn't be discussed in a QSO, but my personal feelings on this subject is different from that of the majority of hams. We are a society and almost a big fraternity of people with different interests and thoughts and if we want to get to know each other better, we should learn by our QSOs how each of us thinks. In the process of my experiment I found many amateurs that went along with my ideas. We discussed topics ranging from Vietnam to women's liberation. But it seems that whenever we would get into a sticky subject one of the members of our society would come on to the frequency and throw a carrier on, whistle Dixie, or sing the Star Spangled Banner, as the case may be. As other groups on the amateur bands have found, whenever someone disagreed with what you are doing – no matter if it is in the form of breaking the norms of the frequencies or conducting a net such as the one conducted by the students – choice stations show their intelligence by throwing all sorts of interference on the frequency. These kinds of people don't deserve the privilege of operating amateur radio.

I'd like to relate a story to the readers of 73. I have a very good friend on 40 meters (K2PJG). Bob is crippled from the waist down and is confined to a wheelchair. He is very active on ECARS and does an excellent job as monitor control. He has frequently been the recipient of all kinds of insulting remarks and has almost given up hope on the bands. I happened to be on the frequency one day when one of our fellow hams came on and started to insult Bob. When I broke in, the fellow insulted me as well. After the QSO I ran into Bob and he asked me if I knew of anyone who wanted to buy his rig. I have also thought about selling my 40 meter equipment.

Going back to my original topic of sex, religion and politics, I feel that the amateur bands might be more exciting and challenging to hams if some other hams would try my method of learning and discussing the problems of the world today. And maybe if more of us discussed problems and issues of the world and the amateur bands, there might be less conflicts and dissatisfied hams today.

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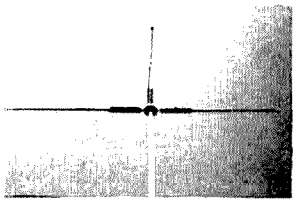
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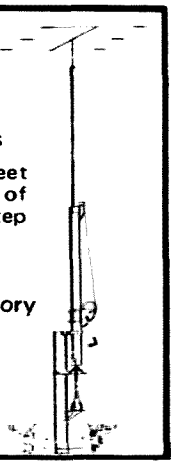
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If any stations wish to discuss the topics I have mentioned, just drop me a line with a sked and if possible we will have an out-of-the-ordinary QSO. Which is pretty rare to find these days.

Jim Millner
116 Cornwall Ave.
Trenton NJ

Incentive Licensing — Pro and Con

The following letters are representative samples of letters received in response to 73's incentive licensing questionnaire. Those opposed to IL far outnumbered those for; thus, we cannot reprint all of the letters against the principle, even though the "for" letters reprinted here are the sum total of all letters backing incentive licensing we received from amateurs as of 1 October.

Pro

Anything as worthwhile as amateur radio is worth the time and effort involved in learning the code (20 wpm). My gripe is that you may interpret my responses to your biased advantage, so I have only answered the questions you will have difficulty biasing.

Jerry Pope W4YRY
5112 Cedarwood Dr.
Raleigh NC 27609

I am for incentive licensing, but I think the principle should be reconsidered, perhaps favoring new bands as an incentive.

Jack Petree WB4OVX
Box 5175
Roanoke VA 24012

The only answer I can give to anyone opposing an incentive of any kind is that he must be classed as too lazy to want to better himself and (improve) his knowledge.

Bill Cooke W3GBB
427 Crain Hwy NE
Glen Burnie MD

I favor IL, but all amateurs who held the original Class A license should be issued the Extra automatically. They earned the top benefits, so why take them away?

Paul Fritich W3HHC
11 Oakleigh Rd.
Allentown PA 18104

I have Extra class...took many days of code practice but consider the time well spent. Some people will never pass the Extra, but most have the capability to do so if they really want to.

Bob WB9ABT
Rt 1 Box 269
Lake Zurich IL 60047

Twenty wpm is the speed of the expert and Extra class should be expert. Incentive licensing gives one something to strive for, keeps the mind strong. Without (such an incentive program) some people would tend to grow stale. I think incentive licensing should be as the name implies – an incentive, something extra – not something restored that was previously taken away.

John Mrozinski WB2EXI
155 Eckford Street
Brooklyn NY 11222

Con

"Indian giving" – that is, offering something in exchange for a demonstrated proficiency in certain skills then revoking that something – is a very poor way of creating goodwill.

M. W. Macy W9UM
Rt 4
Syracuse NY 46567

I want to see ham radio grow – why not give it a chance? The Generals should be given back all the bands taken from them. If incentive is necessary, let the Extra have a small part of one band for phone and code. It is not hard to see why so many people say to hell with the FCC and the ARRL and go to CB where they can have almost as much enjoyment and can work the country without all this nonsense!

Roy Gunter K9GNK
1637 Rock Spring Dr.
Alton IL 62002

In spite of the fact that I am against IL, don't get the idea that I do not study and strive to improve my knowledge of amateur radio. It's just that I would rather see us go back to the previous system.

Richard Weiner WA8WMC
Rt 2 2560 Lincoln Rd
Ludington MI 49431

Hams in Alaska are under a particular hardship with respect to upgrading because of the tremendous distances involved in getting to Anchorage (where exams are administered). But I am against IL regardless of where I am located. Thanks for standing up for the majority of amateurs, who are against incentive licensing.

Jack Bone KL7GKY
Sitka, Alaska

I'm certainly glad the FCC doesn't have anything to do with my birth certificate, marriage license, bachelor's degree, etc., where revocation of privileges could really be serious!

C. H. Smith K0ERL
611 Wesley Dr.
Farmington MO 63640

Granting extra privileges to a few at the expense of the majority is hardly justifiable. The ARRL never proved it was speaking for a majority – surely the FCC must know that!

Theron Lillie WA2UIG
190 Henrietta St.
Rochester NY 14620

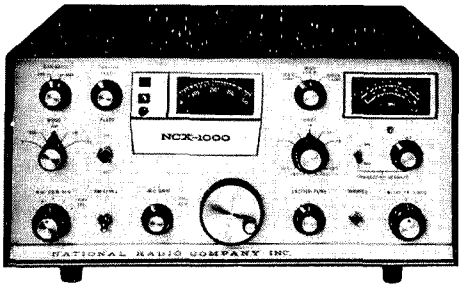
I don't favor IL the way the ARRL presented it and as far as I am concerned they can go to h— with their incentive licensing.

John Perlick WB0ADO
3400 Edgewood Ave North
Minneapolis MN 55427

Thanks for giving us hams the opportunity to express our feelings about IL. I do not favor the principle. I can see no useful purpose in knowing how to send and receive CW at 20 wpm unless someone simply wants to be a faster operator. The entire mess has dealt a severe blow to amateur radio; I sincerely hope the FCC will reopen the whole matter for reconsideration.

Kenneth Cregar K3KBG
3411 Stoudt's Ferry Bridge Rd
Reading PA 19605

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My low opinion of IL is colored by the personal blight of downgrading after more than a half-century of good behavior on the ham bands. It all seems so unnecessary. I would think that old experienced people could be let alone and not subjected to such indignities as have been dreamed up from time to time by the ARRL. I can't be mad at the FCC, who – I am sure – simply felt that Newington could hardly be wrong. As a matter of fact I recall that the FCC turned this thing down some years earlier on the basis that it would lead to an elite establishment with a supposedly democratic government put in the anomalous position of enforcing a caste system.

R. A. Hilferty W2HEY
Box 409
Miller Place, LI, NY 11764

I hope that someday this incentive licensing thing can be rehashed...Now I have a General license which restricts me to certain portions of the amateur bands ...and the ironic thing is that Extras seem to operate in the General portion of the band.

John Stagnaro W6MAB
2305 Panorama Dr.La Crescenta CA 91214

I don't have any idea how much influence you will be able to swing in your effort to convince FCC that this whole thing was ill-advised, but if I can help by sending you my opinions, then it is the least I can do. I am against IL, and would only be for a 20 wpm requirement if use of a typewriter were optional.

Bill Gulledge W9LWG
Rt 3 Box 56
Phillips WI 54555

Finally someone uses a magazine to get opinions on the IL program on a national scale. I hope that 60% of votes is not the losing percentage (see p. 9 QST Sep 1970).

Harris WB8BTV

It's not incentive licensing when the FCC narrows and removes frequencies so as to load the remaining spectrum with nets and phone patches. And cramming ARRL activities into the highly congested remaining portions of the bands is idiotic.

R. W. Daniels K0KYH
Rt 2 Box 212
Aitken MN 56431

IL was supposed to be a step above General; instead, the space between Novice and Extra was split in three rather than two. And the present General is not up to his predecessor, who knows half the Advanced test from his old General exam. Thus, either increase the exam requirements for Advanced or throw it out! Let those who know the code at high speed get credit for it, but let the chap who doesn't know it demonstrate some alternate ability. If the FCC insists on restricted privileges, how about power? New Generals to get 150W, maybe Advanced and Extras could get the full gallon.

Joel Look W1KCR
Box 25
Claremont NH 03743

Radio Interference Reduction

Some hams try to purchase new electric razors for neighbors in an attempt to reduce existing razor QRM. However, attempts I have made to find any razor that is treated to reduce QRM, have not been successful at dealers. Finally, I received a reply from a SEARS buyer who said that their 92737 razor (Austrian) claimed to be so treated. I had read many instruction sheets with new razors without seeing any such comment on other products.

I think that the magazines should be willing to mention this, and to list products that have reduced QRM.

Note Public Law 90-379, 90th Congress, which amends the Comm. Act of 1934, permitting FCC to regulate the interference potential of devices. QST published a request for letters to FCC suggesting items heading such regulation.

I think that amateurs should encourage FCC to bring out at least a general requirement that household appliances be treated for reduction of QRM, and especially that thermostats be treated to prevent "hanging" of the contacts in a sparking condition. Also, essentially all light switches could be so treated – which I understood was required in France 35 years ago. I encourage the magazines to stir up a little thought on the use of the Public Law to reduce QRM.

E. H. Conklin K6KA
402 Oliveta Pl. Box 1
La Canada CA

Sparkling

Keep up the good work with 73 Magazine. You have a good following at KEYN. We have four active hams on the staff. Our News Director KØWTM has his two young sons licensed as Novices. I'm now working on the general manager and his oldest son and hope to get them tickets. The station supports the WØDKO repeater with tower space and power. You can imagine the response a CB organization receives when our program director (W5MGC) takes the call. Our weekend disc jockey and engineer WAØTHQ is a senior at Wichita North High School. Oh yes, we also operate a station WAØZZX on 2 meter FM from the KEYN studios.

Anyway we here at KEYN heavily support Amateur Radio and 73 Magazine. Each copy I receive from my new life subscription is well digested before I safely file it away.

Larry Waggoner WAØQPM
KEYN, 3357 W. Central
Wichita KS

Lackluster

I keep reading in the letters column the bouquets that come your way regarding the magazine. I started subscribing some time ago and thought the same way – even got the back issue Gunsmoke and enjoyed them all. However, in the last year or so, it seems to me that 73 has lost its sparkle and is becoming a lackluster publication. 'aybe it's me, maybe not. Anyway, it seems to be turning into a specialty-type magazine geared for VHF-Novice interests. Of course, maybe this is what you want.

I wonder how much the advertiser influences editorial policy? I have yet to see an article saying that a particular piece of equipment is a piece of junk. These "reviews" in all the magazines claim that anything is the biggest thing

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since the ice cream cone. For instance, I had a Swan VHF antenna, made by the Stockton man, that flew apart in the wind, mainly because of insufficient hardware. I wrote something about it and sent it in – no response. Wrote another and sent it to QST – and got a nice letter from the technical consultant that they only checked the 2 meter, not the 6 meter.

I believe there is a little more than a year to go on my 73 subscription and I frankly don't intend to renew it for a lack of interest in the contents.

Paul Schuett WA6CPP

A lot can happen in a year

. . . Ken

Easter Island

On March 20, 1970, I was licensed to operate my amateur station from Easter Island with the call sign: CEØAE. I have been operating with this sign since May 20, and work all bands, CW and SSB. Only twice have I operated above 21,400 on the 15 meter band. My name is "Dave", my QSL Manager is WA3HUP, and my QSL card is red and white. I do NOT have an APO address. I have received fewer than one QSL card for every three contacts, and would appreciate more. My usual frequencies are: 28,550 – 21,360 – 14,332 – 7030 – 3530.

Fr. David L. Reddy, O. F. M.
Parroquia
Isla De Pascua, Chile

Flamboyant

In my opinion your increasingly flamboyant headlines lower the appearance and appeal of 73 to the level of cheap trash like CQ and PE, and waste space that could otherwise be devoted to several more pages of articles.

73 is not Movie Mirror or True Confessions. For examples of proper headlines for a technical magazine see July QST.

R. B. Kuehn WØHKF
St. Paul
MN

The Good . . .

A friend loaned me the June and July copies of 73 magazine. They're the greatest. I saw your notice about a bundle of back issues of 73 for $6.00. My check's enclosed. Hope I'm not too late.

I'm in a Code & Theory class. As soon as I get my Novice ticket, I'll subscribe to your fine magazine. Can't see how any amateur can be without it.

My sentiments are with your point of view on every issue in these two issues of 73. Keep up the good work.

Jim Edwards
Chillicothe OH

. . . and the Bad!

In your recent letter asking me to renew my subscription you said that you were worried that I would not renew my subscription. Well Gentlemen I would like to say that you had better start worrying for your publication has become sheer garbage in the past 9 months. If you want to sell your mag, you had better try the funny farm for they are the only people that might find your magazine of interest!

Lloyd Dolese Jr. WN5ZZF
220 E. Maple Ridge Dr.
Metaire LA

Mideast

Wayne's helping Hussein out was a true gesture of gentlemanliness in the true ham spirit. I guess you just have to remind some people that you are not a discriminating person. To me, Hussein is a person who has same common interest as myself, ham radio, and this ham fellowship (to me anyway) is not affected by either race, creed, color, religion or place of birth. As for those childish kids who say, "OK, now go to Israel or you're anti", let them go somewhere!

Wayne has befriended a great ham for all of us. May I remind some people that Hussein has understandable troubles of his own and he gets on the bands (like most of us, anyway) to relax and take it easy. You must forgive some of us, Hussein, for those pileups, but you're still a rare one for many of us. Take it easy and as long as you are a member of the fellowship of hamdom, I won't yell at you about the Mideast. My feelings remain much the same for Wayne. Keep up the good work. Times, they are a-changin'.

Chip Cohen WA1JHO

Ham Critic

It strikes me, Wayne, that the technical quality of the articles is slipping. "More Notes On Diode Stacks"" must have been written for the Novices or the XYLs. Maybe my interests just were not touched – we'll let it go at that.

Brown (W9HBF) must not have listened recently on CB; further, he should keep track of what hams do in emergency communications. I could have enjoyed the Sept. issue a lot more if this article had not been in there! QRP, yes – CB, no!

WB4ITN could have something real useful going with his file-box series if he handles it correctly, and produces some really handy gadgets for the shack.

One has to question the use of the word "waveguide" in KICLL's attenuator article. Two coffee cans soldered together will do the same job only it's called shielding!

There are a lot of pluses in the Sept. issue: W7PUG's CW ID Generator, WA2IKL's IC Testers, K6MVH's Antenna Separation, and Douglas's Relay, etc. The study guide material is always excellent. Too, WB6YVT's 2M Converter looks good.

It is noted that the number of advertisers seems to be picking up, Wayne. Anyway, I guess you know that I read "It" from cover-to-cover. Thanks.

73's Carl K2IA
10-16 Burbank Street
Fair Lawn NJ

In regard to the letter by Ernest Robarge, who says he would make a good ham except he can't pass the code exam, it really made me laugh. Over 600 hours of code and he still can't pass it. I took 16 hours for my Novice and passed with no trouble. So as far as code goes I'm okay but I can't get enough theory to pass the General. But I'm still going to keep on and not write to 73 to tell the world what a fool I am.

Bob Mackey WN9ERZ

Somebody's sure been writing letters over your signature. . . . Ken

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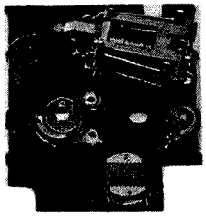
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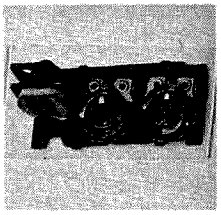
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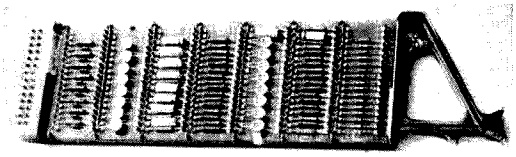
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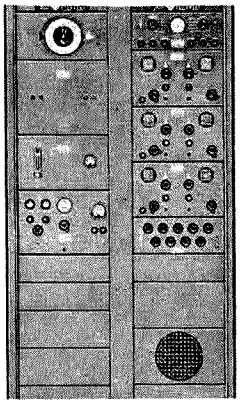
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ARR-15 from June 1965 73, page 78.
ARC-27 2M Guard Channel Receiver.
SSB Transceiver, Nov. 1961 73, page 23.
R508/ARC, June 1965 page 48, before & after.
73 Magazine, Peterborough, N.H. 03458



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Atlanta Repeater Problem

K6MVH's recent editorial on the Atlanta repeater was an accurate description of the situation as it now exists in that area. I lived in Atlanta for over five years and still maintain my "4" call because of frequent trips to the Atlanta area. The group which originally began construction of the Atlanta repeater consisted of serious amateurs with a desire of promoting the growth of FM activity. This group was gradually overtaken by a group of ex-Army MARS operators who, after a change in command of the MARS group, became dissatisfied with the Army MARS FM repeater program. This group then used its political and financial contacts to establish the Stone Mountain repeater. This group has never liked to have its inner circle questioned, even while affiliated with MARS.

There still remain a few stations who will work transient mobiles. However, the control station will not work anyone with what he calls a "Yankee Brogue," which includes anyone who does not come from the 4th call area. I have been called down by that station because he cannot understand anything but deep southern drawl!! On my last visit I made the statement on the repeater that the Atlanta area was getting a bad reputation in FM circles. This stirred up some comments, both pro and con. However, it did serve to wake up some of the operators in the Atlanta area, and, for several days every transient operator was worked by several stations. Thus, I hope that Ken's editorial did some good.

Glen Zook K9STH
818 Brentwood Lane
Richardson TX 75080

73 Reader Service Coupon

Now we don't say that every single reader must buy every last product advertised in 73. We believe that, but we don't say it. The very least every reader can do is to put on a show of interest in the products herein advertised. To make this a simple task, even for the laziest reader (now there is a contest for you!), we have cleverly arranged the advertising index to double as a readers service coupon. All you have to do is tear it out (or photocopy it) and send it in with the appropriate boxes marked. (We have a prize for the most boxes marked . . . a silent prayer of thanks from the publisher). We'll accept postcards, slips of paper, or almost anything else that lists the companies you want to hear from and your address.

No one likes to go into a store without buying something, right? It is the same with these information requests. You will be expected to buy something. Oh, it doesn't have to be a $50,000 antenna system, but it should be something modest . . . a transceiver . . . a linear . . . you know. We'll leave the decision up to you, knowing that we can trust you to do the right thing.

And we are definitely not saying that the use of this service coupon has any curative powers, but we cannot but notice that many readers report remarkable relief from simple backache, headaches, lumbago, and acid indigestion after sending in their coupon. Why take any chances?

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13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7A	7	3A	7	7	3A	7	14	21	21	21
ARGENTINA	14	14	7A	7	7	7	14A	21A	21A	21A	21	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14B	21	21	21	21A
CANAL ZONE	14	7A	7	7	7	7	14	21A	21A	21A	21	21
ENGLAND	7	7	7	3A	7	7	14	21A	21A	21	14	7
HAWAII	21	14	7B	7	7	7	7	7B	14	21A	21A	21
INDIA	7	7B	7B	7B	7B	7B	14	21	14	7B	7B	7
JAPAN	14	7A	7B	7B	7	7	7	7B	7B	7B	7B	14
MEXICO	14	14	7B	7	7	7	7	14A	21A	21A	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7	14B	14B	14B	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	14
SOUTH AFRICA	14	7A	7	7B	7B	14	21	21A	21A	21A	21	21
U. S. S. R.	7	7	3A	3A	7	7B	14	21	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21	21A	21A	7

CENTRAL UNITED STATES TO:

ALASKA	21	14	7	3A	7	7	3A	7	14	21	21A	21
ARGENTINA	21	14	14	7	7	7	14	21A	21A	21A	21	21
AUSTRALIA	21	14	14	7B	7B	7B	7B	14	21	21	21	21A
CANAL ZONE	21	14	7A	7	7	7	14	21A	21A	21A	21A	21A
ENGLAND	7	7	7	3A	7	7	7B	14	21A	21	14	7B
HAWAII	21	14	14	7	7	7	7	7	14	21A	21A	21A
INDIA	7B	14B	7B	7B	7B	7B	3B	14	14	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7	7B	14B	21
MEXICO	14	14	7	7	7	7	7	14	21A	21	21	21
PHILIPPINES	21	14	7B	7B	7B	7B	7	7	14B	14B	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21A	21A	21	21
SOUTH AFRICA	14	7A	7	7B	7B	7B	14	21A	21A	21A	21	21
U. S. S. R.	7	7	3A	3A	7	7B	7B	14	14	7B	7B	7

WESTERN UNITED STATES TO:

ALASKA	21	14	7	3A	3A	7	3A	3A	7	14A	21	21
ARGENTINA	21	14	14	7	7	7	7	14A	21A	21A	21A	21
AUSTRALIA	21A	21	14	14	7	7	7	7	14A	14A	21	21A
CANAL ZONE	21	14	7A	7	7	7	7	14A	21A	21A	21A	21A
ENGLAND	7B	7	7	3A	7	7B	7B	7B	14A	14	14	7B
HAWAII	28	21A	14	14	7	7	7	7	14	21A	21A	28
INDIA	14	14	7B	3B	3B	7B	3B	3B	14	7B	7B	7B
JAPAN	21A	21	14	7B	7	7	7	7	7	7B	14	21
MEXICO	21	14	7	7	7	7	7	14	21A	21	21	21
PHILIPPINES	21A	21	14	7B	7B	7B	7	7	14	14	7B	14A
PUERTO RICO	21	14	7	7	7	7	7	14A	21A	21A	21A	21
SOUTH AFRICA	14	14B	7	7B	7B	7B	7B	14	21	21A	21	21
U. S. S. R.	7	7	7	3A	7	7B	7B	7B	14	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21	21A	21A	21

A = Next higher frequency may be useful also.
B = Difficult circuit this period.